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Section for the Study of Disease in Children

President—R. C. JEWESBURY, D.M.

[*May* 24, 1935]

Recurrent Attacks of Jaundice.—REGINALD C. JEWESBURY, D.M.

Patient, a girl, aged 8 years, has during the past three years had attacks of jaundice, accompanied by abdominal pain and vomiting. They have occurred at intervals of four months and are of four or five days' duration.

Past history.—Full-term baby. Birth-weight 8½ lb. Measles, mumps, whooping-cough, chicken-pox.

Family History.—Father and mother healthy, two other children aged 11 and 5 years, healthy. Housing conditions good.

In July 1934, during an attack, her appendix was removed at Rochester Hospital. The most recent attack, the second since the appendicectomy, began on May 7, with abdominal pain, vomiting, headache, and jaundice, and on May 15 she was admitted to St. Thomas's Hospital.

On examination.—A fairly nourished child; jaundice marked. Rigidity and tenderness all over right side of abdomen. Pain referred to right iliac fossa, but maximum tenderness 2 in. below right costal margin. Edge of liver felt 1½ in. below right costal margin in nipple line. Spleen not enlarged. Temperature 98° F.; pulse 120; respiration 22. Stools pale. Urine bile-stained. Van den Bergh reaction: direct positive. Suggested diagnosis: gallstones.

Discussion.—Dr. F. PARKES WEBER suggested that the case was one of "cystic dilatation of the common bile-duct," or as he, for certain reasons, preferred to call it, "megalocholedochus." Painful recurrent crises, more or less resembling gallstone colic, occurred in 37 out of 83 cases (Sénèque and Tailhefer). As the intermittent jaundice in such cases was of obstructive nature, the blood-cholesterol was likely to be raised in connexion with the attacks. If an exploratory laparotomy showed the presence of cystic dilatation of the common bile-duct, the best result would (according to statistics) be likely to be obtained by choledocho-duodenostomy.

In regard to his preference for the term "megalocholedochus," Dr. Weber referred to his papers in the *British Journal of Children's Diseases*, 1934, xxxi, pp. 27 and 113.

Mr. BARRINGTON-WARD said he thought that this was a typical case of gallstones. In his experience pain was not a feature of cyst of the common bile-duct. Gallstones were more common in children than cyst of the bile-duct. He had operated on a girl aged 8 and a boy aged 9; in each case he had performed cholecystectomy. The nature of the operation should not be decided upon until the state of affairs could be revealed by operation.

POSTSCRIPT.—Laparotomy was performed by Mr. P. H. Mitchiner; the gall-bladder was found to be thickened but contained no stones. The bile-duct was clear but a single enlarged gland was lying near it. The gland was removed and the gall-bladder was not opened. The child made a good recovery and has had no further attacks of jaundice or pain since the operation. The gland, on microscopic examination, had the appearance of a sarcoma. R. C. J.

Rickets with some Unusual Features.—REGINALD C. JEWESBURY, D.M.

J. S., a girl, aged 3 years. Parents healthy. Three other children said to be healthy; one child, now aged 5 years, did not walk until over 3 years old; one child died (? from meningitis at 13 months).

Past history.—Full-term baby. Birth-weight 8 lb. Normal labour. Breast-fed for "a few months," then had Nestlé's sweetened milk until nearly 2 years old. "Some solid food" given after one year. Teething did not begin until end of first year. Has never walked. Talks a little. Has had measles and chicken-pox.

History of present illness.—The child cannot rise from a sitting position unaided. The mother thought that she was slow in development, but as the older child had

J. S., 21.8.35.

walked very late she did not take her to hospital until a few weeks ago. She can feed herself, and appears to be normal mentally. She frequently lies with her feet up against her chin. Appetite good. Bowels normal.

On examination.—A fairly nourished child, but much undersized. Weight 20½ lb. Teeth good, jaws well formed. Head flat, large in proportion to body—circumference 19 in. Skull bones thin. Fontanelle closed. Ribs beaded: Harrison's sulcus.

Clavicles bowed. Some bowing of forearms, epiphyses at wrist enlarged. Tibiæ: backward bowing. Abdomen normal in outline. Marked hypotonia of muscles.

Skiagrams: Bones show signs of acute rickets, with very marked general decalcification.

Serum calcium 10·2 mgm. %. Inorganic phosphorus 2·4 mgm. %.

Urticaria Pigmentosa (Nodular Type).—RAYMOND KIRK, M.B., M.R.C.P. (for GEORGE BRAY, M.B., M.R.C.P.).

D. H., male, aged 8 months.

Birth-weight 6 lb. 7 oz. Normal pregnancy and delivery. Skin quite normal at birth. Breast-fed three weeks, then given Nestlé's milk. Soon after this the mother noticed some mottling of the skin below the knees, as if the child had been in front of the fire. This mottling changed to red blotches, which spread over the body, face and head, and came and went. When they faded a few days later, nodules were noticed which soon reached their present intensity. The condition has remained unchanged since it first appeared at 4 weeks of age.

Family history.—Father, lead-worker for ten years, healthy; mother healthy; no consanguinity; three other children: (1) died at birth; (2) a girl aged 9½, healthy; (3) a boy aged 6½, healthy. Paternal grandfather had asthma.

On examination.—Child well nourished, healthy in appearance and cheerful. The surface of the body is covered with nodules, oval or circular in shape, varying in size from 5 to 10 mm. in diameter, and yellowish in colour, some being surrounded by a reddish areola. They are evenly and thickly distributed over the scalp, face, neck and chest, but are most numerous on the flexor aspects of the thighs, where individual nodules have coalesced to form plaques in a few areas. They involve even the genitalia, ears, palms, and soles, but no lesions are seen in the mouth. The skin over some is stretched, whilst over others it is wrinkled, but everywhere its surface is normal, both over the nodules and in the narrow intervening areas. The nodules do not irritate, and many are replaced or surrounded by violaceous stains. All other systems appear normal. Blood chemistry—cholesterol 162 mgm. %, sugar 96 mgm. %. Wassermann and Kahn reactions negative.

The feeds have been changed several times (cow's milk, allergilac, baby diet) without any apparent effect upon the condition.

Biopsy of a nodule showed the corium to be infiltrated with mast-cells.

There are no signs of glandular enlargement, and there is no dermatographism. Examination of the blood shows no abnormality and skiagrams of the chest are clear.

In the literature, up to 1925, there had been 25 cases of the nodular type of urticaria pigmentosa described, but in few of them were the lesions so extensive as in this case, although the case conformed in all other details.

With regard to prognosis, these cases may follow three courses. In some the lesions clear at puberty and leave no trace, in others scars are left, and in some the lesions remain unchanged.

The general health has always been affected.

Dr. PARKES WEBER said that in the nodular type of urticaria pigmentosa in infants there was apt to be difficulty in diagnosis when the nodules were as large as, or larger than, they were in the present case. Such cases were of extreme rarity. These very chronic nodules could hardly be regarded as manifestations of any allergic condition, as ordinary acute urticaria could be. With regard to the accumulation of mast-cells in the nodules, even if these cells were all derived from the bone-marrow, one would hardly expect to find any obvious increase in the mast-cells in the circulating blood (differential blood-cell count) at any one time.

Recurring Pyelitis in a Boy with Double Ureters and Double Renal Pelves.—REGINALD LIGHTWOOD, M.D.

W. McG., male, aged 5 years.

History.—Has had three attacks of acute pyelitis, with fever, as follows: At 1 year old, at 4¾ years old, and at 5 years old.

On examination.—Apart from being thin, he is a healthy-looking child. No abnormal physical signs. Urine: Normal, no pus cells seen microscopically, cultures sterile.

Uroselectan.—Normal excretion in both kidneys. Double renal pelves and ureters on both sides. Calyces well filled. No evidence of renal disease (Dr. Shire's report).

W. McG.: Pyelogram after injection of uroselectan showing double ureters and renal pelves.

In this patient attacks of pyelitis are associated with a congenital abnormality, namely doubling of the renal pelves and ureters on both sides, and in such cases it is possible that there is either defective muscular action of the structures, or partial stenosis.

Bilateral Double Ureters: Pathological Specimen. — REGINALD LIGHTWOOD, M.D.

Specimen from a boy aged 5 months, who was in the Hospital for Sick Children, Great Ormond Street, for a month before death with intractable pyuria. He died of bilateral pyelonephritis.

At post-mortem examination, a condition of bilateral double ureters was found. (*see* fig. p. 77). Each kidney has two separate pelves. On both sides these two ureters fuse about 1½ in. above the bladder, so that there are only two ureteral orifices into the bladder.

[Dr. Thursfield's case-notes 1928. *P.M.*, vol. *31*, No. 221.]

On each side there were two ureters which came from separate renal elements and fused about two inches above the bladder. (*Specimen shown by Dr. Lightwood.*)

Diffuse Symmetrical Sclerodermia.—T. PEARSE WILLIAMS, M.D.

S. S., female, aged 4½ years. In December 1934 the neck was noted to be hard and swollen, and a diagnosis of mumps was made. The firm swelling was found to persist and to extend. Previous health has been good; the child has had measles and pneumonia only. Eight other children in the family, alive and well.

Present state.—A rather small child, active and happy; weight 28 lb. The skin and subcutaneous tissues of the face, neck, arms and forearms, lower back and belly, and also, but less markedly, the thighs and legs, feel firm and indurated and have the consistence of rubber. There is no discoloration. Urine normal. Wassermann reaction, negative.

Blood chemistry: Urea, 45 mgm., calcium, 10·5 mgm.; phosphorus, 4·5 mgm.; cholesterol, 182 mgm. (All per 100 c.c. of blood-serum.)

Blood-count: R.B.C. 4,270,000; W.B.C. 9,000; Hb. 88%. Differential count: average figures.

Stool: Total fat 35·2% (consisting of 63·6% soaps, 30·7% free fatty acids, 5·7% neutral fats).

Diffuse Symmetrical Sclerodermia.—R. W. B. ELLIS, M.D. (by permission of R. S. FREW, M.D.).

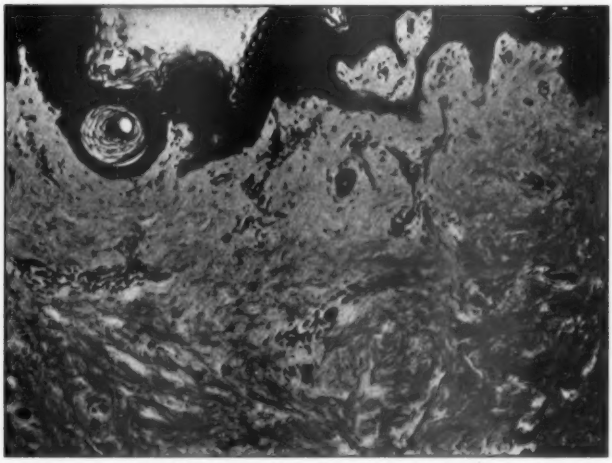
E. S., male, aged 2 years 1 month, was well until January 1935 when he began to cough and had a discharge from both ears and a septic infection of the skin behind both ears. In February 1935, a swelling of the cheek was noticed, and the skin and subcutaneous tissues were felt to be abnormally hard. The aural discharge ceased about this time, but recurred in hospital. His general health has otherwise been good. The parents and two siblings are well.

On examination.—A well-nourished boy, weighing 35 lb., with rather high colour of cheeks; the rest of the skin shows a slight degree of pigmentation. There is slight bilateral ptosis, and the facial expression tends to be fixed, though the boy can smile and masticate without difficulty. There is a generalized brawny induration of the skin, most marked over the cheeks, where it feels almost stony hard. The arms, legs, and neck are more affected than the trunk. The tissues do not pit on pressure. There is a purulent discharge from the left ear. Throat clean. Heart and lungs normal. Liver edge palpable one fingerbreadth below costal margin.

Urine: Shows slight traces of sugar and of indican, but no other abnormalities.

Wassermann reaction (blood), negative. Blood cholesterol, 128 mgm. per 100 c.c.

A portion of skin and subcutaneous fat has been removed from the right thigh for biochemical and histological examination.



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Generalized fibrosis of cutis vera.

Histological examination.—A section stained with hæmatoxylin and eosin, shows a portion of skin and subcutaneous fat in which the cutis vera is very definitely sclerosed by moderately dense fibrous tissue (*see* fig). This latter is represented by coarse strands with very few nuclei, the strands running in all directions. The nuclei of the cells containing the subcutaneous fat stain poorly.

Dr. W. W. Payne reported the following additional observation on the fat removed at biopsy: "Melting-point 24·5° C." The melting-point of a sample of fat

taken at necropsy from a child of the same age was 29·5° C. Dr. G. A. Harrison has reported several melting-points of fat, but only found as low a value in a patient dying of osteomyelitis, the remaining values being closer to the control value.

Comment.—It has been suggested that these cases may be due to chronic staphylococcal infection. In this instance the only source of sepsis that has been found is a chronic aural discharge, from which *Staphylococcus aureus* was cultured. The sinuses appear clear. There is nothing to indicate an endocrine disturbance, and different authors have found the basal metabolic rate raised, normal, or decreased. The pulse and general behaviour do not suggest hypothyroidism in this case, and thyroid has been administered without appreciable effect. It has not been thought justifiable to remove a piece of muscle for section, as the very small superficial wound made for the excision of a section of skin has failed to heal, and has become ulcerated.

Malignant Disease of the Liver. ? Secondary to a Suprarenal Tumour. —J. H. GIBBENS, M.B.

P. S., female, aged 4 years. Brought to hospital with complaint of wasting and frequent abdominal pain, of increasing severity, for the previous eight months. No vomiting; bowels regular; appetite capricious.

On examination.—Small, wasted child. Height 36 in.; weight 1 st. 11½ lb. (Normal for age: height 38 in.; weight 2 st. 5½ lb.) Gross enlargement of liver, extending down to umbilicus; surface smooth, lower edge regular, no tenderness. No ascites or œdema of feet; no jaundice or anæmia; enlarged vein present on anterior abdominal wall between umbilicus and costal margin. Spleen enlarged, reaching 1½ in. below costal margin. Halfway between the umbilicus and the left costal margin there is a small, stony hard mass, lying very deeply, not going through to the loin. In size it feels about ¾ in. in diameter, and it is not tender; size and shape not changed by frequent enemata. Kidneys not palpable. Rectal examination negative. There is also an enlarged mass of glands just above the left clavicle, firm rather than stony hard, discrete and not tender; no enlargement of other glands. Tonsils moderately enlarged. Heart, lungs, skin, central nervous system, long bones and skull, normal. Urine: No albumin or sugar; microscopically normal; cultures sterile.

Blood-count: R.B.C. 4,120,000 per c.mm.; Hb. 70%; C.I. 0·85; W.B.C. 17,500. *Differential*: Polys. 79%; lymphos. 14%; hyals. 5%; eosinos. 2%. No abnormal white cells seen: slight anisocytosis.

Wassermann reaction, negative: Mantoux test ($\frac{1}{10}$ mgm.), negative. Blood-sugar 0·142%. Skiagram of chest: No evidence of enlarged glands. Skiagram of gastro-intestinal tract after barium meal: No abnormality found.

During the six weeks following admission the child has wasted steadily and the liver and the glands in the neck have increased in size. There has been severe abdominal pain on many occasions.

The child caught measles, which broke out in the ward soon after her admission. She made a quick recovery but is left with a discharging right ear. She has been afebrile, except for the period when she had measles.

POSTSCRIPT.—21.7.35: The child died two weeks later. Post-mortem examination showed an enormous malignant growth of the right kidney, which, on histological examination, proved to be a round-celled sarcoma. There were masses of malignant glands in the mesentery, in the portal fissure, and above the left clavicle. There were no malignant growths elsewhere in the body. There was no splenic

enlargement—the " enlargement " felt during life being due to a mass of malignant glands in the neighbourhood of the spleen—nor were there any malignant growths in the liver, the enlargement being secondary to glands in the portal fissure. The suprarenal glands were not involved.

Renal Dwarfism associated with Calcinosis of Kidneys.—R. W. B. ELLIS, M.D. (by permission of W. J. PEARSON, D.S.O., M.D.).

R. H., male, aged 6 years 7 months, first attended hospital at the age of 2 years, suffering from anterior poliomyelitis affecting the intercostal muscles and left

FIG. 1.—Renal dwarf with normal control of same age.

shoulder; he made a good recovery, although pneumonia developed while he was in hospital. Tonsillectomy in 1931. He has had enuresis frequently since infancy, and in May 1933 he suffered from headache and vomiting, and many pus cells were found in the urine. He then weighed 30 lb. (aged 4½ years—normal 38 lb.). In January 1935, he had a severe attack of vomiting lasting a week, and in February

1935 he complained of frequent headaches and pain in the lower abdomen. He has had polyuria and polydipsia recently (duration uncertain). The parents and four other children are well.

On examination.—Poorly nourished, undersized boy, weighing 33½ lb. (normal 47 lb.); height 40½ in. (normal 45½ in.) (fig. 1). The nose is persistently red, but otherwise he is of good colour and normally active. There is slight genu valgum, but no other obvious rachitic deformity. Examination of heart and lungs negative. Blood-pressure 105/75. Fundi normal. The boy was thirsty whilst in hospital (18.3.35-25.4.35) and had polyuria, passing up to 1,500 c.c. of urine in the twenty-four hours. Micturition performed normally; no dribbling or dysuria.

Mantoux test negative.

Urine (repeated examinations): Pale, clear, alkaline or neutral; specific gravity approximately 1010; albumin, a cloud or trace consistently present. A variable number of white cells present and occasional red blood cells. No tubercle bacilli seen in twenty-four-hour specimen.

Blood examination: Hæmoglobin 101%.

X-ray examination (Dr. Shires): Wrists and ankles show changes of early renal rickets. Kidneys: Multiple small opaque deposits in both kidneys (fig. 2).

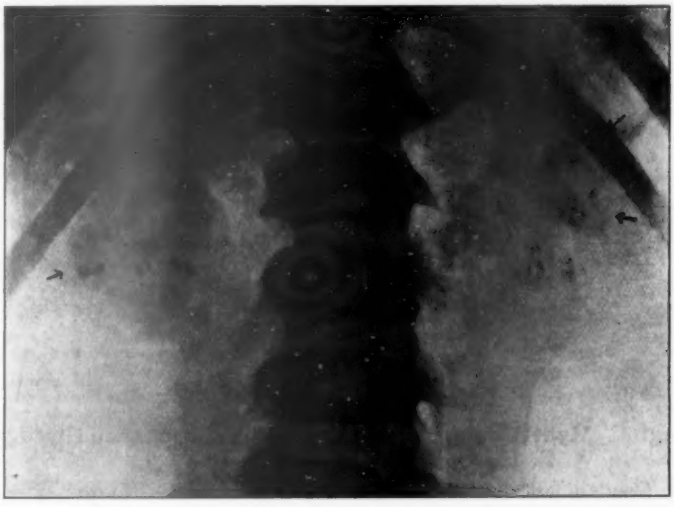

FIG. 2.—Multiple small opacities around calyces of both kidneys.

Uroselectan: Delayed excretion, bladder filling in one and a half hours. Renal pelves not well defined. Retrograde pyelogram: Normal pelves; opacities grouped round calices (fig. 3, p. 82).

Biochemical Investigations (Dr. Payne).

Urea clearance test: Maximum clearance 44 or 60% of normal average; standard clearance 29 or 54% of normal average.

(Values below 80% of normal average should be considered as indicating renal damage.)

(1) Blood urea 72 mgm. %.
(2) Blood urea 66 mgm. %.

Urea concentration test :

	Before urea	1st hour	2nd hour	3rd hour
Urea %	1·26	1·21	1·60	1·25
Volume c.c.	85	65	60	163

Blood urea : 12.4.35, 36 mgm. % ; 19.3.35, 30 mgm. %.

Serum calcium 8·6 mgm. % ; inorganic blood phosphorus 3·0 mgm. % ; plasma phosphatase 14·5 units ; blood cholesterol 193 mgm. % ; plasma albumin 4·13 ; plasma globulin 1·51 : plasma fibrin 0·30.

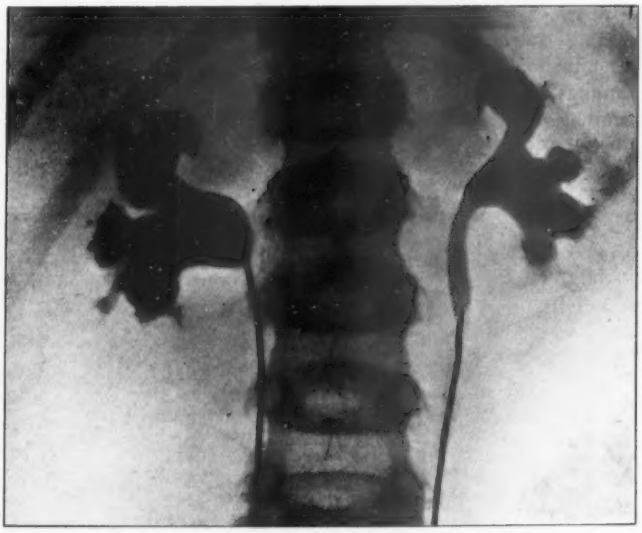

FIG. 3.—Retrograde pyelogram showing normal pelves ; opacities grouped around calyces.

Congenital Hypertrophy of Heart ? (Cardiomegalia Glycogenica) : Specimen.—R. W. B. ELLIS, M.D.

From a female infant aged 4 months, who was admitted to hospital under Dr. Hutchison, with a history of never having cried normally, and of becoming progressively more feeble. The infant had at first gained weight on the breast, and had then been weaned, owing to feeble sucking. Family history negative ; mother's first pregnancy.

Condition on admission.—All movements of limbs were very feeble and there was partial paralysis of the intercostals. Some limitation of flexion of elbows, hips, and knees. Tendon reflexes absent. Muscles felt rather increased in size and firm (similar to those in pseudohypertrophic muscular dystrophy). Electrical reactions showed that the muscles of both arms and legs responded, though feebly, to faradic current. Pulse 130. Area of cardiac dullness not determined. Skiagram of muscles showed normal outlines. Wassermann reaction negative.

The child was fed by tube, but breathing became more dyspnœic, and death occurred, being apparently due to respiratory paralysis.

Post-mortem examination (forty-eight hours after death).—The heart weighed 73 grm. (normal, approximately 25 to 30 grm.); it was globular, firm, and greatly enlarged in all diameters, measuring 7 cm. from apex to right border and 4·5 cm. from above downward. Enlargement was principally due to hypertrophy of the left ventricle—the wall of which was 2·5 cm. in thickness—but the walls of both auricles and of the right ventricle were also hypertrophied (fig. 1). No appreciable dilatation. Pericardium and origin of great vessels normal. Aorta showed no coarctation. Coronary arteries given off normally from aorta. No stenosis or other abnormality of cardiac valves. Myocardium firm and of normal colour.

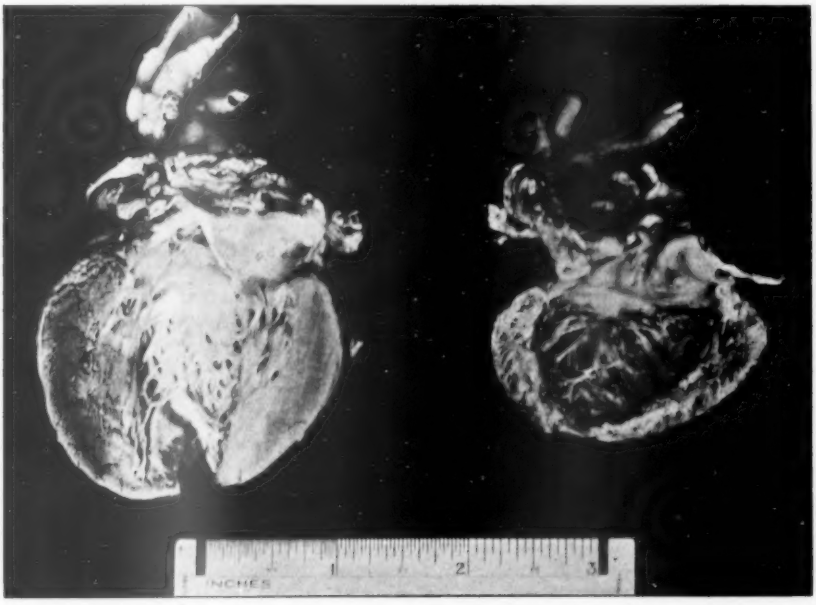

FIG. 1.—Hypertrophy of heart (with left ventricle pinned open) with normal heart from infant of same age (4 months).

Histological examination.—Myocardium (right and left ventricle): Paraffin sections stained with hæmatoxylin and eosin, and frozen sections stained with Sudan III, both showed very extensive vacuolation of the muscle fibres (fig. 2, p. 84). The vacuoles were round or oval in shape, and appeared empty. There was no evidence of fatty infiltration. The nuclei stained normally. Sections were stained for glycogen with Best's carmine, but only after the tissue had been in an aqueous solution of formaline for several days; the result was negative.

Paraffin sections (stained hæmatoxylin and eosin) of gluteus maximus and gastrocnemius muscles showed a closely similar appearance.

Dr. Greenfield, who kindly examined the sections, considered that the condition was probably the same in both the myocardium and skeletal muscles, and represented a generalized infiltration of the muscular system with some substance, possibly glycogen, which had disappeared from the preparations. In the absence of frozen sections of the skeletal muscles, however, it was impossible to say definitely that the spaces seen were actually within, and not between, the muscle fibres.

Comment.—Examples of congenital hypertrophy of the heart which have proved to be due to glycogenic infiltration and have shown a somewhat similar histological picture to the above, have been reported by Pompe in a female child of 7 months,

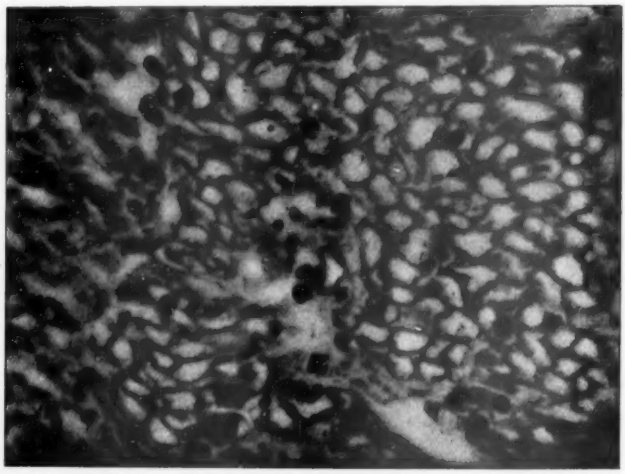

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FIG. 2.—Myocardium showing vacuolation of muscle fibres.

and by Antopol, Heilbrum and Tuchman in a male of 4½ months. Pompe described the cardiac muscle as showing "un réseau de mailles rondes, ovales, ou plus allongées," their shape depending on the angle at which the fibres were cut. The liver cells were similarly affected, and the vacuoles within both myocardium and liver cells stained with Best's carmine, although the tissue had been in an aqueous solution of formalin for over forty-eight hours, suggesting that the glycogen present was abnormally stable.

It is unfortunate that in the present case the autopsy was not carried out until forty-eight hours after death, and that it was several days before the possible presence of glycogen was suspected and the tissue transferred to an alcoholic solution. Consequently it has not been possible to demonstrate the presence of glycogen in the vacuoles, though it appears at least possible that this case represents another example of Von Gierke's glycogen disease, in which the muscular system is principally affected.

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ANTOPOL, W., HEILBRUM, J., and TUCHMAN, L., *Ann. Journ. Med. Sci.*, 1934, clxxxviii, 354.

Infarcts and Aneurysm of Heart in an Infant of nine months: Specimen. —R. W. B. ELLIS, M.D.

Male, aged 9 months. An only child of healthy parents; forceps delivery after long labour; head thought to have been large since birth, and to have increased gradually in size. Admitted to hospital under Dr. E. A. Cockayne, 13.3.35, on account of hydrocephalus; head then measured 19¾ in. in circumference. Discs normal. Legs spastic, with exaggerated knee and ankle jerks, and well marked ankle clonus. Nothing abnormal detected in heart or lungs. Cerebrospinal fluid normal, under increased pressure. Wassermann reaction negative.

FIG. 1.—Aneurysm of heart projecting at apex, with infarcted area above.

The infant was discharged home, 20.3.35, but readmitted to hospital ten days later with severe gastro-enteritis. After temporary improvement his condition rapidly deteriorated and purpuric rash appeared two days before death (28.4.35).

Post-mortem examination showed communicating internal hydrocephalus and bronchopneumonia of both lungs. Both middle ears contained thick green pus.

Specimen: Heart weighing 35 grm. The pericardium was smooth, but showed pale areas corresponding with two nodular projections from the wall of the left ventricle (fig. 1). One of these, situated at the apex, was thin-walled, collapsed on pressure (showing a terminal dimple), and refilled when blood was squeezed into it

from the ventricle. The second was firm, and situated on the left border, above the apex. On opening the ventricle, the myocardium at the apex was found reduced to a thickness of 2 mm., the projection seen externally representing an aneurysm formed within an area of infarction. Above this the wall was pale and swollen; two smaller areas of infarction were seen in the wall of the left ventricle anteriorly (fig. 2).

FIG. 2.—Aneurysm of heart: left ventricle opened to show aneurysm at apex, and pale infarcted areas above.

Microscopically the myocardium of the left ventricle showed necrosis and degeneration of muscle fibres, with many areas of inflammatory infiltration, polymorphonuclear leucocytes predominating.

Nodular Kidney in the Left Iliac Fossa.—R. H. BAILEY, M.B. (for Dr. DONALD PATERSON).

M. D., male, aged 3 years, suffering from lichen urticatus. The mass was discovered on routine examination by the family doctor.

Condition on admission.—Healthy-looking child with lichen urticatus over body. Abdomen: Mass felt in the left iliac fossa toward the midline. No tenderness or rigidity on palpation, no urinary symptoms. The mass was freely movable, and slightly nodular, with one larger nodule at the upper end.

Rectal examination: The mass is easily felt and moved bimanually, and can be lifted out of the pelvis with the examining finger. It is anterior to the wall of the bowel.

Urine normal. Wassermann reaction negative.

X-ray examinations.—Straight skiagram of abdomen: nothing abnormal seen. Intravenous pyelography (Dr. Coldwell): "No definite sign of dye in left kidney or ureter. Right side normal." Barium enema: "No obvious sign of mass connected with the colon."

Examination, under anæsthetic, by Mr. Price Thomas, revealed a swelling, of the shape of a kidney, which could be replaced into the loin.

Juvenile General Paralysis of the Insane.—G. H. NEWNS, M.D. (for Dr. WILFRID SHELDON).

R. C., male, aged 4 years, was admitted to King's College Hospital, complaining of weakness of the lower limbs.

His symptoms first appeared about two years ago, and consisted of irritability, inability to walk like other children, and a tendency to cry rather easily. A year later weakness of the legs was first noticed; this has become worse since the onset of a cold a week before admission.

Previous health good; no serious illnesses; no history of fits. Full-term infant, instrumental delivery.

On examination.—Noticeably abnormal. He is quiet when alone, but when approached, becomes excitable and very talkative. His speech is very difficult to understand, only isolated words being intelligible; the consonants are not well articulated.

Mentally he is not dull but rather sharp, and takes a good deal of interest in his surroundings. Emotionally he is facile and easily amused. He seems to have a mentality which is deteriorating rather than one which is primarily deficient.

Cranial nerves: Right pupil dilated and fixed, no reaction to light or with accommodation. No external ophthalmoplegia. Optic fundi normal. Arms: No muscular weakness or ataxia. All the abdominal reflexes are present. Legs: Slight weakness and increase of tone. Tendon reflexes very much exaggerated, but no clonus. Bilateral extensor response.

Sensation is everywhere normal. There is no ataxia of the gait, which is, however, not normal. The boy walks stiffly without bending the knees and with slight dragging of the legs.

Investigations.—The cerebrospinal fluid is clear and is not under pressure; no clot. Cells are less than 2 per c.mm.; protein, 20 mgm. per 100 c.c.; sugar, within normal limits.

The Wassermann reaction is positive, both in the blood and in the cerebrospinal fluid.

Congenital Stenosis of the Duodenum treated by Gastro-enterostomy.—DENIS BROWNE, F.R.C.S.

G. G., male, aged 18 months. Born weighing 7½ lb. At 14 days old began to vomit; at 21 days weighed 5½ lb.

The vomiting was projectile; there was visible peristalsis, and a large tumour was felt under the upper part of the right rectus. Dr. Ellis suggested a duodenal stenosis, and at operation this diagnosis proved to be correct.

Under a local anæsthetic a posterior gastro-enterostomy was performed, and though there was some vomiting during the next week, the child did very well. He is now an exceptionally fine boy for his age.

At operation the duodenum was found to be greatly dilated in its first and second parts, this dilatation being the tumour that had been felt, but the exact nature of the obstruction was not seen.

Skiagrams now show a rapid and complete passage of food through the anastomosis, no food entering the duodenum.

Section of Epidemiology and State Medicine

President—J. D. ROLLESTON, M.D.

[*May* 24, 1935]

Epidemiology in Country Practice

By WILLIAM NORMAN PICKLES, M.D.

VISITORS to Wensleydale have been struck by the fact that a tiny hamlet gives its name to a noble dale. This tiny hamlet of Wensley, in the reign of Queen Elizabeth, was a proud market town of 1,800 inhabitants, and on applying to its well-preserved parish register, the reason for its decline is seen beyond doubt. 10 x 5 0

In the year 1563 the flourishing town was attacked by the plague. "Hoc anno nullos quia desunt quaere sepultos" writes the learned clerk, almost in a hexameter. There were doubtless many deaths, and at what transpired to be the traditional burial place, bones have been recently dug up, but it is probable that the townspeople, including the clerk, precipitately fled and never again inhabited the accursed spot.

From the register, by a later hand, we find: "The reason as some think that nothing is found written in the Register in the yeare of our Lord God, 1563, because in that yeare, the visitation or plague was hote and fearfull so yt many fled and the Towne of Wensley by reason of the sickness was unfrequented for a long season. As I find by one old writing dated 1569, by Jo. Naylor."

Much is to be learned of the epidemic history of the past by a diligent search of these parish registers, but much must be left to conjecture.

Year after year these registers show the passing of the aged and worn-out with but little to disturb an ordered journey from cradle to grave, and then deaths occur in clumps, eight or nine in all too short a spell, little peaks of mortality, which must have been due to some epidemic disease of a nature impossible now to identify. But of all these records none is so striking as the record in our own time of November and December 1918, the period of the great influenza epidemic, when the death-bell was seldom silent and the sexton's robin reaped its full harvest. My own limited experience of the registers would lead me to suppose that epidemics of a fatal nature rarely occurred in Wensleydale.

In the year 1841, an enlightened vicar of Askrigg and an undoubted protagonist of vaccination, records eight deaths from smallpox in six weeks, and adds a marginal note, "numbers 794 to 801 inclusive died of smallpox, all being unvaccinated except no. 799, and she being sickly. Upwards of 80 cases of smallpox in Askrigg and only one death after vaccination."—R. Wood (Vicar). I think it is obvious that he meant in a vaccinated person.

You will forgive me dipping into the past, but it is clear that there is something to be gleaned from these old registers.

It is given to those of us who do our work in country districts to trace the origin and spread of an infectious disease with an accuracy made possible by our intimate knowledge of the lives of those who are our patients. Their friends, their relations, their habits and pastimes, their love-affairs, the markets they frequent, the occasional trips to the seaside or the pantomime, and other details of their

relatively simple lives, are matters of common knowledge. We stand therefore on a strategic pinnacle for the investigation of epidemic disease. The opportunities of infection are few, and are traceable in a way that is impossible in the crowded, varied life of a town.

Some years ago I had the good fortune to meet Dr. Alison Glover, then of the Ministry of Health, and on his advice I devised a method of investigating epidemic disease in my practice by the means of charts such as are employed in the School Epidemic Investigation of the Medical Research Council.

A typical chart is reproduced. On the left are the villages arranged in what I consider their natural grouping. The dates are written above, and a coloured square, varying for each disease, is allotted to a single case, which is marked on the chart below its date of origin and opposite the village in which it occurs.

The charts are in book form and the names of the sufferers are written on the page opposite the chart with the date of origin of the particular disease and under its appropriate symbol.

To assess it at its lowest value, this has proved to me a most interesting hobby, something to turn the face from the clod and to add interest to the daily round, which, instead of being monotonous, becomes full of delightfully exciting incidents.

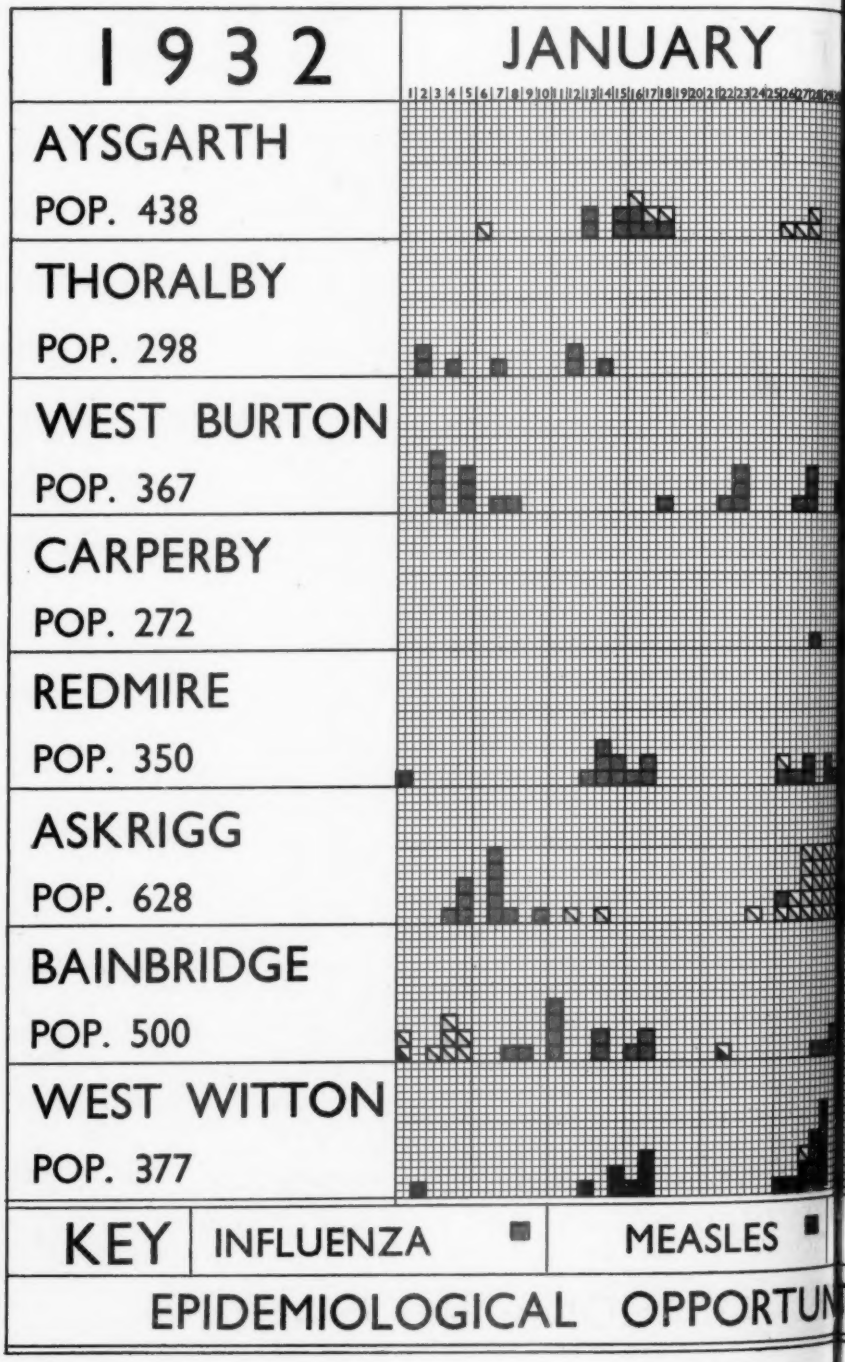
But authority is not infallible; the experience of those who have worked before us may be open to question, and in the light of such charts, old beliefs may have to give place, in rare instances no doubt, to knowledge based on what one believes to be an accurate record of fact.

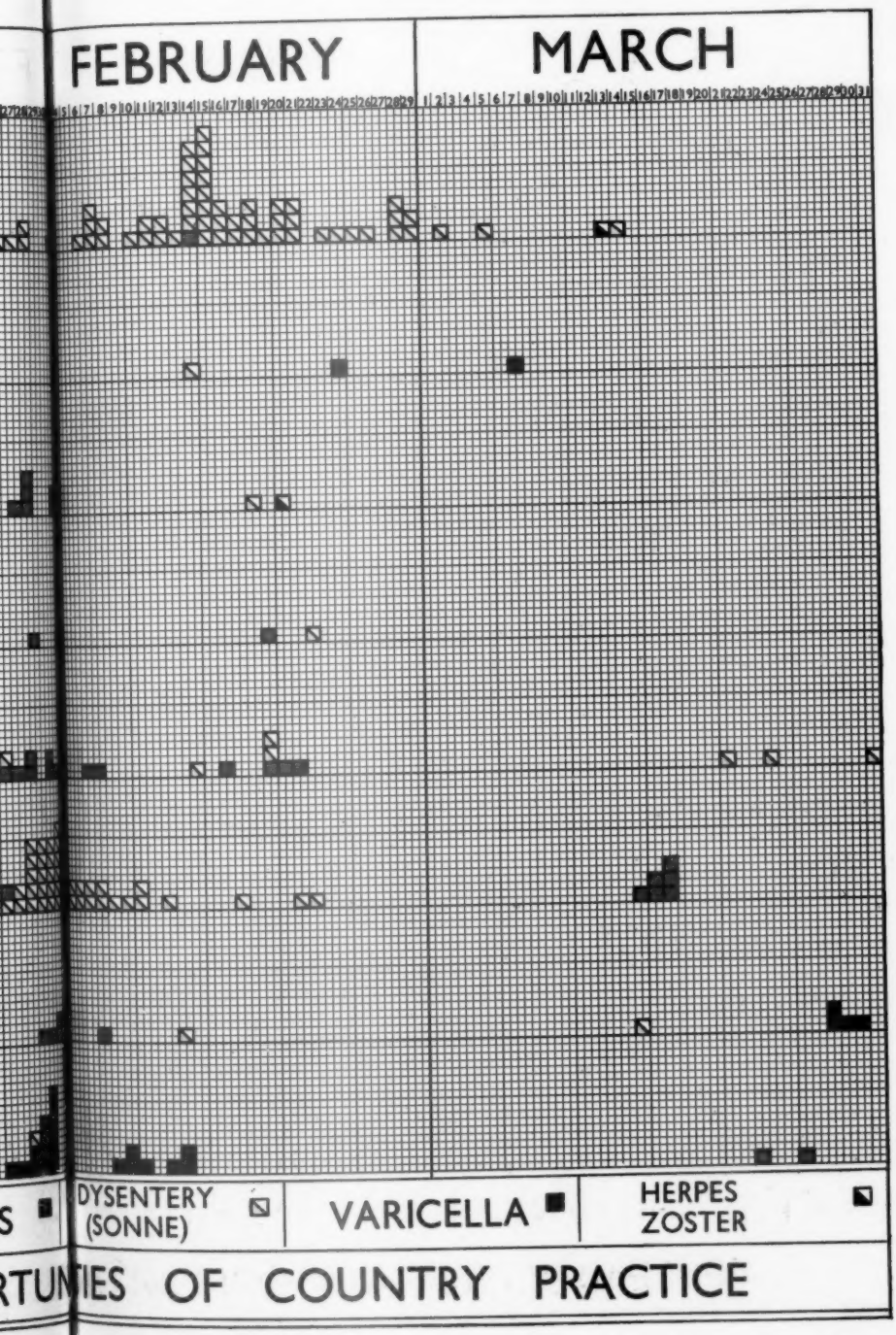
In the determination of incubation period, the charts appear to me to be of the maximum value. With humility and with the full consciousness of a beginner, I venture to dispute the wide latitude of some of the textbooks in the incubation period of measles, to take a common disease. Long before I kept charts, according to my own experience, I felt satisfied that this did not vary from seven to eighteen days.

The incubation period of the egg of a bird, the gestation period of a mammal, the menstrual cycle, do not vary between such wide limits. The rhythm underlying this was fixed, once and for all time, eons ago, on the tidal beaches, and it seems reasonable to suppose that the periods of incubation of infectious diseases will show as little variation.

Occasionally a case of measles will be seen in the charts which does not appear to have any connexion whatsoever with other cases in the district. Here is an instance: (1) A man in a village remote from the prevailing epidemic of measles exhibited the disease. Twelve days previously another man called at my surgery and, finding no one at home, repaired to the inn conveniently situated on the other side of the road and sat cheek by jowl with the first man over their pints. Returning later to the surgery he was found to be suffering from the measles. He appeared to me without a reasonable doubt, during the short visit to the inn, to have infected his companion and the incubation period was most accurately twelve days.

Here is another instance in which the incubation period can be accurately stated: (2) A boy in a farm place arrived at the surgery and announced that he had "gitten mazzles" (contracted measles). This was certainly the case and he was told to go to his mother's home, shout to her outside the door and have the living-room cleared of his small brothers and sisters. He then proceeded to his bedroom, where he remained a fortnight. On the twelfth day after his arrival, his aunt—and only his aunt—became a victim of the disease, although she had never seen the boy and left the house the morning after his arrival. It was found that the boy's bedroom and the living-room, directly below, by an unusual and capricious arrangement of the builder, were lighted by one long window giving direct aerial access from one room to the other. The meal table was below this gap and the aunt, who sat directly underneath at meals, was undoubtedly thereby infected.


1932
JANUARY
AYSGARTH
POP. 438
THORALBY
POP. 298
WEST BURTON
POP. 367
CARPERBY
POP. 272
REDMIRE
POP. 350
ASKRIGG
POP. 628
BAINBRIDGE
POP. 500
WEST WITTON
POP. 377
KEY
INFLUENZA
MEASLES
EPIDEMIOLOGICAL OPPORTUN



IES OF COUNTRY PRACTICE

I could multiply such instances and contend that incubation periods can be accurately traced, as the source of infection is rarely in dispute.

Many epidemics of catarrhal jaundice have been recorded in late years but there is a difference of opinion on the incubation period. Possibly there are two forms of the disease, one with a long incubation period and the other associated with tonsillitis with a 2-5 day incubation period. Of this latter I have no experience and am rather sceptical. I will give two striking records, which, whilst strongly supporting an incubation period of approximately a month, show the ease of tracing the spread of an infectious disease when the life of the people is bound up with one's own daily life.

RECORD OF OUTBREAK OF CATARRHAL JAUNDICE

A. The first case
Not attended personally, but said to have had jaundice in July 1929. It is impossible to trace the infection in his case, but it is significant that he visited Askrigg, a hotbed of infection, in June

B. (A's sister)
Commenced with the disease on August 23, and whilst still obviously jaundiced, attended a village fête at Thornton Rust on August 28. All these cases below were present at the fête and developed the disease on the given dates, all 1929

Mrs. C. (Sept. 24). B. was known to have been in her house during the day	D. (Sept. 24)	E. (Oct. 1), (who spent the afternoon with B.), a maid in West Burton, who was proved to have been in contact with the following cases, which subsequently infected others	F. (Sept. 25)	G. (Sept. 28)

H. (Nov. 5), small son of E's employer	J. (Nov. 4.), a friend of H. and E.	M. (Nov. 5), an admirer of E.	P. (Oct. 27), great-aunt of E.
	K. (Dec. 8), (brother of J.)	N. (Dec. 5), brother of M. (same house)	
	L. (Jan. 8, 1930), a friend of K.	O. (Jan. 4, 1930), sister of N. (same house)	

Here is a record of a spread of this infection in a family of young adults and among their friends.

Name	Illness commenced	Remarks
Jane	August 16, 1929 ...	Infection not traced
Sarah	September 14 „	
James	„ „	
William ...	October 11 „	
G. S.	October 12 „ ...	A great friend of the family, often in the house
Ann	November 7 „	
Jennie U. ...	November 6 „ ...	A little girl inseparable from the family
W. M.	December 4 „ ...	Fiancé of Ann
D. U.	December 2 „ ...	Two-year-old sister of Jennie U.
Jho. U.	December 29 „ ...	Father of U. children

Whilst on the subject of epidemic catarrhal jaundice, I wish to make an observation on its infectivity. To return to the table: Why did not the other secondary cases occur on or about September 14 when James and Sarah were stricken? To my knowledge William, G. S., Ann and Jennie U. were all exposed to infection on or about August 16. I can only conclude that the degree of infectivity is not high and is of short duration. The monthly periodicity of the disease in families is most marked and can only be explained by a short infectivity period.

I am disposed to throw out a suggestion that a proportion of the cases of catarrhal jaundice that are seen in everyone's practice are sporadic instances of this

infectious disease. In my twenty-two years' experience in Wensleydale, I have only seen one case of catarrhal jaundice which I could not prove was a part of an epidemic or directly traceable to another case.

Our own epidemic in 1929-1930 consisted of 250 cases, among a population of 5,700, and out of these I attended 118 personally.

There were no fatal cases, but one man was off work six months, and at least four had symptoms which were thought at first to be those of a perforated duodenal ulcer. As we remarked at the time, the distance of thirty odd miles from hospital and surgeon was, for once, in the patient's favour, as the cases cleared up in a few hours, and escaped unnecessary abdominal section by a narrow margin.

The methods of spread of an epidemic in a country district are, of course, somewhat different from those prevailing a century ago. The peaks of mortality to which I have referred were confined to a single village and there is no evidence of extension from one locality to another. People stayed at home in olden days, and even within my own memory there were men and women who had never been in a train and had never visited the neighbouring towns.

Most of the villages had a feast on the day of their particular Saint, which attracted a few from the surrounding neighbourhood, but it is only of late years that there can be considered to be anything like communication with the outside world.

Epidemiology could have been studied here in an earlier age as effectively as Professors Greenwood and Topley study it in their herds of mice, and I do not consider it altogether different in the present day, although certain factors in modern life prevent the village from being the closed community it was, or very nearly was, in the past. We have our whist-drives and dances, and our local cinemas, all of which are available to the denizens of a large area in these days of motor transport.

There has been a policy of late years to close the smaller schools and convey the children to the schools in the larger villages, which, however excellent in educational results, assists materially in the spread of epidemics.

Recently, a head-teacher returned from a holiday at a seaside resort, when our district had escaped the epidemic of influenza which was sweeping the large centres. Though realizing that she was ill, with praiseworthy, if mistaken, zeal, she attended school for one brief morning session. I regret to have to state that 78 typical cases of influenza were directly traceable to this unfortunate attendance. We are here, of course, in a position similar to that of the recording angel. The lady herself, if she knew, would be horrified at the havoc for which she was responsible.

We have also a very good local Grammar School, to which our people owe much in the way of better education but, serving a very large area, it is frequently responsible for the spread of epidemics.

Three years ago, we experienced a severe epidemic of Sonne dysentery. Some of the patients were very ill, though we were fortunate in having no fatal case. I came to the conclusion that this infection was spread by the schoolchildren, as in no house were the adults attacked first and it was probable that the defective personal hygiene of the children and the primitive sanitary arrangements provided at school were responsible for the transfer of the organism from child to child and so from child to parent at home.

The period of infectivity of the various infectious diseases might well be a problem which work on these lines will help to solve.

Some years ago a small girl who had been excluded from school for three months after an attack of scarlet fever, on her return left all her school-mates unscathed, but quite obviously infected an adult with whom she had taken tea during the first week of her freedom.

In the case of measles the opposite obtains. We exclude our children from contact with others for a fortnight, whereas I verily believe that the disease is not infectious for very long after the rash has appeared.

The chart-keeper will experience the thrills associated with the diagnosis of the rarer infectious diseases.

Undulant fever may appear at any time on one's records and looking back I feel sure that three cases of prolonged pyrexia with few symptoms, but with an enlarged spleen, were of this disease. In my time there has been no epidemic of glandular fever, but several sporadic cases have occurred of this very interesting condition.

In the early morning of a bright July day in 1933, I was disturbed from my bed by a young farmer who, I knew, was of a placid disposition and gifted with common sense. However, this time he was thoroughly alarmed. "Would I come and see one of his small boys who had been taken suddenly ill?"

This boy, 2½ years of age, had been quite well and lively whilst being dressed, but was then suddenly attacked with pain in the upper abdomen, sweated profusely and, his mother thought, had had a fit. When I saw him the pain was not so acute, but he seemed limp and ill and I had not the slightest idea what was the matter with him. Shortly after, my late partner, Dr. Dean Dunbar, saw him in a return of the acute pain and suggested it was a painful spasm of the diaphragm.

We saw him together at 3 p.m. His face was then flushed, his temperature was 101° and his respirations were definitely 60 per minute. This rate, we knew, was exceedingly high; neither of us could remember ever having previously counted such a rate. The child had an expiratory grunt and a short cough, and even in the absence of physical signs, we thought we were justified in suggesting to the parents that he was suffering from acute pneumonia.

Later in the day he seemed better; his temperature was 100° and he had no pain.

The next morning the little rascal was standing on the window-sill and thumped on the pane and greeted me smilingly as I walked up the garden path. His temperature was 98° and I could find no trace of any symptom or sign. Notwithstanding this, on the following day he had a complete replica of his first day of illness with the addition of a pain in the back which prevented him raising himself from the bed. He had no symptoms on the fourth day except a violent nasal catarrh and an evening temperature of 99·8°, and thereafter completely recovered.

The household consisted of father, mother, and three brothers, in addition to this patient. Two brothers, aged 4 and 6, were similarly attacked, and two little girls, friends of the family, who were never out of the house, were also victims. Finally the father of the boys was also a sufferer, and the little epidemic came to an end.

Two days before the first boy showed symptoms, a small girl visitor from the York neighbourhood had spent the day with the family. She spent it on the sofa, crying with pain in the abdomen, and there seems little doubt that she was the infecting case, although we were quite unable to trace the origin of her illness.

This week of illness was naturally a most trying one for us. We had cases of what was obviously an infectious disease, of which we had no previous knowledge whatever.

However, the year before, a Copenhagen practitioner, Dr. Sylvest, had written to me on the subject of catarrhal jaundice, and had enclosed a paper on a disease, which he called variously Bornholm disease, epidemic myositis and, from American sources, "the Devil's grip." I was unable to read his writing in the original, but the references to American papers on epidemic pleurodynia and epidemic transient diaphragmatic spasm made me suspect that we were dealing with the same disorder. His paper in French, kindly sent to me by Dr. Glover, settled the matter without a shadow of doubt.

During the succeeding two months more than a dozen cases of the same disease occurred, and there was a small epidemic in Askrigg last year. The disease

sometimes masquerades as an abdominal condition. One of the children appeared to me at first to be suffering from acute appendicitis, and another from renal colic.

It seems certain that this disease will crop up at intervals in this country, and the possibility should be borne in mind, so that a most puzzling and alarming condition should not escape diagnosis, or, worse still, be mistaken for an acute abdominal condition. It is really only a mole-hill, but it has a very striking superficial resemblance to a mountain. The disease has now received the name of epidemic myalgia.

Country beliefs may be helpful, and should not be cursorily ignored. Classically the world gained much when Edward Jenner listened to one of these, and solved the riddle of the milkmaid's flawless cheek. William Withering was not above learning from the old woman who sold dropsy cure.

In Wensleydale the connexion between herpes and chickenpox was well recognized, and I felt rather small many years ago when I was propounding this as a new discovery and the patient interjected: "My mother always said they were the same disease."

In my charts the association between herpes zoster and epidemics of chickenpox is well shown, though I can only prove direct infection in three instances.

In a study of this nature one man in one practice can do little. I have written this and a previous paper in the hope that other country doctors will realize what is peculiarly their opportunity and, I feel very strongly, their bounden duty.

[The coloured chart is reproduced from the *Leeds Medical Society Magazine* by kind permission of the Editor.]

Section of Tropical Diseases and Parasitology

President—P. H. MANSON-BAHR, D.S.O., M.D.

[*May* 2, 1935]

Tuberculosis in Man in the Tropics

By H. HAROLD SCOTT, M.D., F.R.C.P.

I HAVE had the good fortune to work on the subject of tuberculosis in three widely separated parts of the world, each of which may aptly be described as a pathologist's paradise.

First, for some years in the West Indies, where the only stipulation for a post-mortem examination was that I should take away some organ or piece of tissue with me. The reason for the stipulation was that the "duppy," or spirit of the dead, returning to its customary haunts, would search for the missing fragment and would haunt, not the relatives, but myself who had deprived it of something which belonged to it. In the face of this I had no difficulty in obtaining leave for autopsies—in fact the request was almost welcomed.

In this part of the world tuberculosis was common among the natives and I learned a good deal from these autopsies.

My second paradise was in the Far East. Here, one of my duties was to perform autopsies, and the poorer class Chinese have a habit, a welcome habit, of depositing their dead in the street and their dying or unwanted children on the steps of the local convent. In these circumstances my average was just over 4,000 autopsies a year and in this part of the world tuberculosis was very rife.

My third experience of paradise was midway between these two, namely London, where I for some years enjoyed the post of Pathologist to the Zoological Society. There, too, I made full notes of every post-mortem examination and later I thought it would be well to bring some order out of these records. By the kindness, first of Sir Walter Fletcher, and through him of the Medical Research Council, these results were embodied in one of the Council's Special Reports.

So much for my credentials. The rôle assigned to me this evening is to give "an account of the spread of tuberculosis and consequent pathological changes as they occur in tropical natives."

After much thought I have decided to take a few instances of tuberculosis in monkeys, draw parallels between them and human cases as closely analogous as have come within my experience, and then pass on to the disease as I have seen it in tropical countries.

It is not my intention to deal with the ordinary well-known straightforward cases—i.e. of undoubted respiratory origin in an early or late stage, or alimentary disease primary or obviously secondary to pulmonary, and so on.

But as matters of interest—for themselves and also as topics for discussion—I will bring to your notice a few anomalous, or apparently anomalous, cases in primates and quote some human analogues.

Case I.—A sooty mangabey died after being sixteen months in the Zoological Gardens. At the autopsy extensive pleural adhesions were found on both sides, infiltrated with tubercles. In the left 8th intercostal space, in the mid-axillary line, was a hernia of the pleura containing lung inflatable viâ the trachea. In both lungs tubercles were numerous with caseating foci; the heart was thrust to the right, the pericardium attached to the diaphragm by a caseous mass and the diaphragm itself infiltrated with caseous deposits. The tracheo-bronchial glands were enlarged, caseated and adherent. In the lower part of the ileum was a solitary

ulcer with tubercles on the serous aspect. Two mesenteric glands were caseated. The only other lesions were miliary tubercles in the meninges along the right Sylvian fissure, none at the base. It is well to stress here a fact, known to all pathologists but liable to be lost sight of, that in deciding as to the portal of entry of a tuberculous infection from the post-mortem findings in man or animals, the greatest caution is necessary. In very early cases it is quite easy to infer the portal of entry from the most prominent glands, but once the disease is generalized, one might draw almost any conclusion from the distribution of the lesions in the viscera.

I think that in this case there is no doubt that the original portal of entry was respiratory and that the extensive lesions in the pleura, pericardium, and diaphragm were due to direct spread. The intestinal ulcer was due in all probability to swallowed sputum, for animals, except the ill-mannered llama, never spit. The meninges must, I suppose, have become involved by the blood stream; if so, it seems strange that the other viscera—spleen, kidneys, pancreas, etc.—should have escaped. The association, to me rather striking, of pulmonary tuberculosis with meningitis, usually miliary and probably terminal, was found in twelve of my reported cases. The following is a human case bearing many resemblances to that just mentioned:—

The subject was a child of 7 years. There was a small sub-apical cavity in the upper lobe of the right lung—which incidentally consisted of two lobes only—with tuberculous bronchopneumonia in the rest of that lobe and early ulceration in the upper part of the lower; a similar condition, with a rather larger cavity, was present in the lower lobe of the left lung; pleural adhesions were fairly general and also interlobar. Mediastinal glands were enlarged and caseated on the right side; less so, but present, on the left. Peritoneal tubercles were seen over the sites of several ulcers in the ileum and the upper series of mesenteric glands were caseous and adherent. No other organs were affected except the meninges, in which milia were present at the base.

Case II.—A brown capuchin, *Cebus fatuellus*, one and a half years in the Gardens. There was widespread tuberculous bronchopneumonia but no involvement of the pleuræ. The tracheobronchial glands were enlarged and caseated on both sides. The mesentery showed sparse tubercles and the intestinal mucosa several, but no ulceration: the mesenteric glands were massed together and caseated. There was a caseous abscess at the attachment of the falciform ligament of the liver, several small tubercles in the cortical region in both kidneys, no involvement of the spleen. The right inguinal glands were swollen, caseous and broken down.

The following human case presented many analogies with this; I will describe it briefly before discussing the portal of entry and route of dissemination in the monkey.

A child, aged 10 months, with caseated cervical glands on both sides, various stages of tuberculous bronchopneumonia, grey tubercles, caseated foci and in one lobe a small cavity. There were tubercles all over the pleuræ, visceral, costal, interlobar and phrenic. All the mediastinal glands were enlarged and there was caseated and early stage intestinal ulcers, milia in the liver and rather larger in the spleen, aggregated tubercles in the lower pole of the right kidney, inguinal glands on both sides enlarged to the size of cherries, caseated and tuberculous. No abnormality seen in the meninges.

Dealing first with the monkey: Which was the probable primary portal of entry? In the lungs the condition was widespread and the corresponding glands severely affected; in the intestine the tuberculosis was not advanced but the glands were matted and caseated, and the abscess in the liver at the attachment of the falciform ligament indicates disease of some duration.

The following scheme will save a lengthy description: Considering it first as a primary lung infection, the tracheobronchial glands would become affected, thence the spread would be via the veins to the pulmonary circulation; there would be generalization in the lungs, and passage through the lung capillaries to the systemic circulation, thus accounting for the tubercles in the cortical region of the kidneys.

Swallowed sputum would give rise to the intestinal infection. To account for the tuberculosis of the inguinal glands we must bear in mind that in the Cebidæ, or New World monkeys, there is no thoracic duct. The glands in the region of the renal veins are in contact with the superior mesenteric glands, and these, as stated, were caseous. The inguinal glands would become involved by a retrograde flow through the lumbar lymph-trunk from these "renal" glands.

Let us now consider the probable course of events, presuming that the original portal was alimentary. Thence the mesenteric gland enlargement would arise and thereafter there may be two routes of extension: (*a*) By the inferior vena cava to the right side of the heart and so to the lungs, producing widespread lesions; as stated above some of the bacilli might escape through to the systemic circulation and produce the renal tubercles. (*b*) From the mesenteric glands infection might pass through the lumbar to the inguinal glands and drainage from these would conduct the organisms to the falciform ligament setting up the focus there. I am inclined to the latter route, the alimentary (*see* Tables A and B).

TABLE A

Primarily intestine

Mesenteric glands

Inf. vena cava	Through lumbar glands
Lungs (miliary)	Inguinal glands
Small numbers of bacilli passing through to systemic circulation	Secondary drainage from these into the falciform ligament
Kidneys	

The alternative, in our opinion the less likely, route would be:—

TABLE B

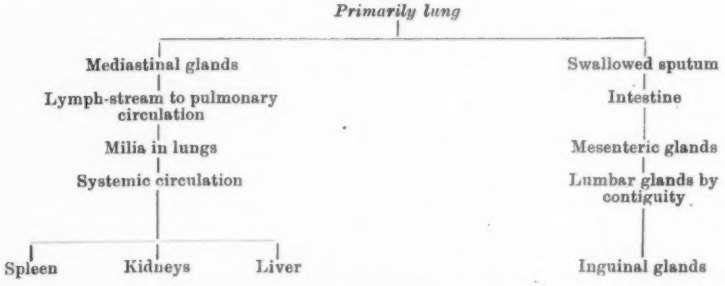
Primarily lung

Glands at root	Swallowed sputum
Lymph-stream to pulmonary circulation	Intestine
Miliary in lungs	Mesenteric glands
Systemic circulation	"Renal" glands
Kidneys	Lumbar glands
	Inguinal glands
	Falciform ligament

In comparing the human case with this we must bear in mind, first, that in the Cebidæ there is no thoracic duct, secondly, that the pulmonary lesions from their general state of caseation and cavitation were almost certainly older than the early-stage ulcers in the intestine, and thirdly, that the latter probably arose from swallowed sputum. The most satisfactory interpretation to my mind is: Primary infection of the lungs, then mediastinal glands, and later the pulmonary circulation by way of the veins, thus, generalization again in the lungs, producing the milia which were universal in both lungs; thence to the systemic circulation to lodge in the liver, spleen and kidneys. Again, by swallowing of sputum the intestinal tuberculosis would result and the corresponding enlargement of the mesenteric glands,

and by direct continuity, of the lumbar, and later, through these, of the inguinal glands (as shown in the following table).

TABLE C

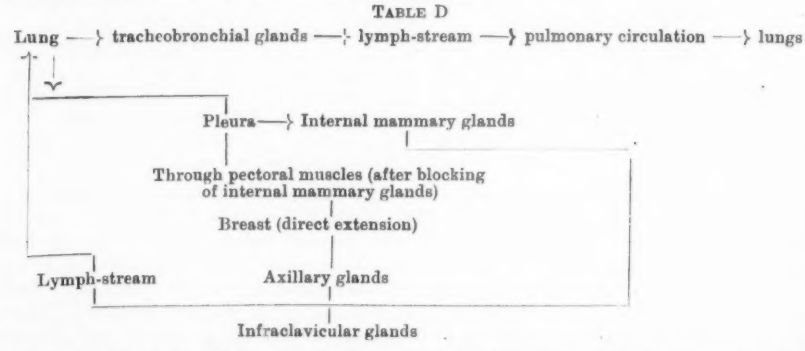


One more instance in a monkey of the same species as the last is worthy of mention because of the peculiar distribution.

Case III.—The left mammary gland was lumpy and contained caseous foci; the left axillary glands were caseated and breaking down, the pectoral muscles on the left side were infiltrated and pus in them communicated with the breast, above which was a tuberculous sinus opening from a tuberculous infraclavicular gland. Scattered tubercles were present over both pleuræ and tuberculous bronchopneumonia was present in both lungs equally. The mediastinal glands were enlarged, matted and caseated. There was no affection of intestine, liver, spleen or mesenteric glands, but tubercles were in fair numbers in the cortical region of both kidneys. The tonsils were not affected.

The primary portal and the route of extension are, I admit, matters of conjecture here, but having regard to the widespread bronchopneumonia and the corresponding affection of the glands related thereto, I suggest the following: Primary pulmonary, then the tracheobronchial glands, through them the lymph-stream and viâ the pulmonary circulation generalization in the lungs. Also from lungs to pleura and so to the internal mammary glands directly. The caseation and breaking down of the infraclavicular gland points, I think, to blockage from the internal mammary, and direct extension from the latter would explain the condition in the pectoral muscle and through it that of the breast. From this, infection would be carried to the axillary glands and thence back to the infraclavicular (as seen in the following schematic representation).

TABLE D



I cannot do better than give a summary from the appendix of a paper written some time ago by Professor Beattie and myself, epitomizing the comparison between human tuberculosis in early life and the disease in other primates.

(1) Two distinct types of tuberculosis are to be found both in man and in other primates.

(2) The respiratory type is a rapidly fatal infection causing death by generalized dissemination of bacilli by the lymphatics and blood-vessels.

(3) The alimentary (primary) form of the disease is less rapidly fatal.

(4) Alimentary tuberculosis may be secondary to a primary respiratory infection. The disease is transmitted to the gut by the swallowing of large numbers of tubercle bacilli in sputum. Monkeys and apes never expectorate.

(5) In each type of the disease the dissemination of infection by the lymphatic system takes place in the same order in monkeys as in man.

(6) The proportion of alimentary tuberculosis to respiratory is probably much the same in all primates.

(7) Respiratory tuberculosis is identical in young human subjects and in other primates but in later life in the former a modifying factor comes into play. Tuberculosis in early human life is the "natural" form of the disease. In other primates the modifying factor is absent and the adults are affected in the same way as the young animals.

Passing on to another point we may ask: Is there such a thing as congenital infection? Only, I think, by way of a tuberculous placenta. I have elsewhere related the case of a baby, 22 days old, dying with a caseated focus in one lung and numerous grey tubercles in the other; another, 24 days old, with a caseous focus in one lung and grey tubercles disseminated through both; also a third, aged 7 weeks, with a caseous focus in the upper lobe of the right lung, cavitation in the lowest lobe, milia elsewhere throughout this lung, tuberculous bronchopneumonia in the lower lobe of the left lung and scattered milia throughout the upper lobe.

Schluster was able to collect twelve cases of tuberculosis at birth. I have no records later than four years back, there may be more now, but the condition must be very rare and even more rarely discovered, and experimental inoculation in guinea-pigs of emulsions of the organs of fœtuses born of tuberculous mothers yields, I believe, only negative results.

I have analysed the first 300 cases in my series of natives and the sex distribution is shown in the accompanying table. It will be seen that in the whole 300 there were 155 males and 145 females, but the preponderance was entirely in those over 20 years of age. Up to 10 years, males were to females as 4 to 5; between 10 and 20 years they were equal; over 20 years the ratio was 3·6 : 1. This, in China at least, must not be interpreted as implying that the incidence is so much higher in males. The bodies examined were, as regards adults, and alas! some of the children too, those of the labouring class. When the women feel sick they leave the district where they are working and return to their native villages. In fact, the Chinese generally, when ill, make every effort to go back to their birthplace to die. The females can more often do this, the males would if they could, but many cannot afford to leave their work and so remain at it until they can no longer go—they have put off the journey until it is too late: hence the preponderance of males among the adult cases.

	Sex	6 months or under	6-12 months	1-1½ years	1½-2 years	2-3 years	3-4 years	4-5 years	5-10 years	Total up to 10 years
First hundred	M.	—	5	7	—	7	2	2	7	30
	F.	7	10	6	8	4	5	2	4	46
Second hundred	M.	3	7	5	2	5	6	1	3	32
	F.	3	11	4	3	8	2	2	8	41
Third hundred	M.	7	5	8	4	5	4	2	2	37
	F.	5	8	7	4	5	3	2	5	39
Whole three hundred	M.	10	17	20	6	17	12	5	12	99
	F.	15	29	17	15	17	10	6	17	126
Total: both sexes		25	46	37	21	34	22	11	29	225

	Sex	10-15 years	15-20 years	Total 10-20 years	20-30 years	30-40 years	40-50 years	50-60 years	Over 60 years	Total Over 20 years
First hundred	M.	4	—	4	2	1	8	1	2	14
	F.	1	—	1	3	1	—	—	1	5
Second hundred	M.	—	—	—	6	3	8	3	—	20
	F.	2	1	3	1	1	1	1	—	4
Third hundred	M.	—	1	1	3	5	3	3	3	17
	F.	—	1	1	2	2	1	—	—	5
Whole three hundred	M.	4	1	5	11	9	19	7	5	51
	F.	3	2	5	6	4	2	1	1	14
Total: both sexes		7	3	10	17	13	21	8	6	65

Certain generalizations have been made by Canti, Ghon, Albrecht and others who have specially studied the disease in children (see *Quart. Journ. Med.*, 1919, xiii, 71; *Journ. State Med.*, xxxv, 104). In my series many, it is true, agreed with their findings, but a considerable proportion did not; I think, therefore, that it would not be a waste of time to mention some of these, as they will form a fruitful theme for discussion later. I will not trouble you with more than three.

Firstly, then: "It has been found that presence of tuberculous mediastinal glands was almost constantly indicative of a pulmonary focus." The "almost" saves the point here, for it is something of a personal matter as to what proportion of exceptions one can allow under the words "almost constantly." Among the 225 autopsies on children detailed in my report there were 29, or just upon 13%, where this did not hold good. Caseated tracheobronchial glands were present but no focus was discovered in the lungs. Excluding all those in which the portal of entry might have been the alimentary tract and the thoracic gland involvement might have been secondary to the mesenteric, there were twelve with no pulmonary focus. One, for example, was a girl aged 8 years, with enlarged and caseated tracheobronchial glands on the right side and the only other discoverable lesion was in the meninges; (milia were fairly numerous along the Sylvian fissures and over the cerebral convexity; they were present also, but were very sparse, at the base).

Secondly, "When tuberculous mediastinal glands are present they bear a close relation to the focus in the lung." This would seem almost axiomatic, but is certainly not invariably true. On looking through my cases I found seven, at least, in which this was not so. Quotation of one must suffice: A child, aged 3 years, showed a sub-apical focus in the left upper lobe and a cavity in the left lower. In the two lowest lobes of the right lung were sparse milia but there was no focus. A hilar gland on the right side was caseated.

Thirdly, "Where a focus is present in the lung, tuberculous mediastinal glands are constantly found." As a general statement this, the corollary of the first dictum, is sufficiently accurate, and the same holds good in monkeys, but there are exceptions, less commonly, I grant, in native children than in adults. Thus, in a child aged 15 months, the upper part of the upper lobe of the right lung showed tuberculous bronchopneumonia with ulceration; in the lowest there was a cavity as large as a walnut. There were milia and grey tubercles in the upper lobe of the left lung. It is clear that the pulmonary mischief was fairly extensive and advanced, but the glands were not obviously affected; they were not even swollen.

Fibroid or healed foci were in my experience rarely seen in children. In fact, I remember only one—a child aged 3 years dying with signs of recent and fairly widely disseminated disease, in the middle lobe of whose right lung I found an old fibroid and calcareous focus.

I will now give one or two instances of peculiar association of sites which I am unable to explain:—

(1) Limitation of the disease to the lungs (with or without affection of the bronchial glands) and to the meninges. I met with this twelve times in all, seven

in children, and, a fact which may possibly bear on the question, in five of the seven only one lung was involved and in each case it was the right lung.

(2) In another case, that of the girl aged 8 years, already referred to, an inferior tracheobronchial gland on the right side was enlarged and caseated and another, of the superior group, was less affected. I could find no pulmonary or intestinal tuberculosis and the tonsils and retropharyngeal areas appeared quite healthy, but the meninges showed milia in fair numbers at the base, few along the Sylvian fissures and an occasional one on the convexity. There is, I believe, no lymphatic connexion between the lungs and the base of the brain, but this association has its analogue in that of cerebral abscess complicating bronchiectasis, for example.

(3) Other peculiar associations were: Tuberculous ulcers in the intestine, caseated mesenteric glands, numerous small tubercles in the basal meninges and a few on the vertex. This was in a child aged 2 years. (Compare cerebral abscess as a complication of inflammatory conditions of the liver, or even of hæmorrhoids. This comparison, however, merely calls for further explanation, it does not account for the association.)

I have seen, and probably others have seen, lungs, meninges, and spleen as the only sites of lesions. This association was more common than that mentioned above (3). It occurred in 15 instances of my series, and analogous cases occurred amongst monkeys. In another human case, that of a child aged three years, I found caseated mediastinal glands, no focus in the lungs, no affection of intestines, mesenteric glands, liver or kidneys, but the spleen showed milia as did also the meninges.

I will add one more fact which is perhaps worthy of note. In my comparatively small series of 300 cases there was a much greater preponderance of terminal meningitis among adults than among children. Putting out of consideration cases where there was generalization in which the meninges shared, there were 24, and of these, 10 were in children, i.e. 44%, one was an adolescent aged 16, and the remaining 13 were among 65 adults; that is, one out of every five adults with chronic pulmonary tuberculosis showed miliary tubercles in the meninges without signs in the other viscera. In one case there was cicatrization and fibrosis in both apices, a calcareous nodule in one lung, and both pleuræ were adherent at the apices; there was no other lesion except tuberculous meningitis—basal, with pus beginning to collect. There was no mediastinal adenitis and the only history obtainable was "high fever and delirium for two weeks."

Lastly, if, as many maintain (and, with the proviso I have made earlier, my experience coincides with this) "it is rare in the case of children to find a pulmonary focus without a corresponding glandular involvement," it is less rare in adults. Though my recorded cases in adults were few and there is grave danger in attempting to generalize, it seemed to me the exception rather than the rule for such to be seen. Thus, among 65 adults there were 12 with extensive pulmonary tuberculosis, most with cavities (some which were of considerable size) others with a definitely caseous focus, but in none of these 12 was there any enlargement of the corresponding glands. In more than a score of others the glands were merely a little swollen, perhaps congested, but without any caseation as is the rule in children. I excised these and examined them microscopically and found in some—but by no means in all—a few giant cells and tubercle bacilli.

Similarly also, one may find abdominal disease, tuberculous ulceration of the intestine, with very little mesenteric adenitis. I will quote a last instance in this regard:—

A man, aged 28, with advanced phthisis; the right lung showed extensive cavitation, the lower lobe of the left was occupied by an aggregation of small cavities, the upper being converted into what was practically a single large cavity. One gland at the root of the right lung was a little enlarged, the others appeared normal. In the small intestine tuberculous ulcers were numerous, but none of the mesenteric glands showed any caseation.

Finally, there is the question of pulmonary hæmorrhage. It would be rash to generalize, but it may be that hæmoptysis, fatal hæmoptysis at least, occurs only in the "modified," not in the "natural" disease. I did not come across it in any of the 225 children who formed the subject of my report nor have I found it in any of the large number of animals dying of tuberculosis even when the disease in the lungs was extensive and cavitation marked.

Figures as to the prevalence of this disease in various tropical countries are not always reliable and those which I was able to verify at the time have been given in another place. One not infrequently hears that "tuberculosis is increasing" or "is becoming rife" in some Colony or other because there is an increasing percentage of reactors to the von Pirquet, Mantoux, or some form of the tuberculin test. The test is, of course, very valuable and informative, but such a statement is not the right interpretation of the observation. It must be borne in mind that the tuberculin test is indicative of infection and infection only, it is not a proof of active disease.

Among natives in the tropics the infection is often virulent and the course of disease rapid. Thus, a recent Colonial report stated that 70% of those admitted to hospital on account of tuberculosis died and that 60% died within a month of admission. Others give similar accounts and it must be remembered that these are not all patients admitted in an advanced stage of the disease.

Why should pulmonary tuberculosis be so severe among natives in the tropics? Some will promptly reply "virgin soil." Whatever we think of this theory, to me it does not seem to solve the problem. The introduction of the organism is, of course, a *sine qua non*, thereafter its spread is fostered by one or more of several factors—the mode of life, habits (or change of habits), industrialization, overcrowding, general bad sanitation. I will cite just one or two examples. Hindu girls live, till they marry, mainly in the open air. Then comes early marriage, frequent pregnancies, prolonged lactation, want of exercise, being pent up with little air and less ventilation, poor food and all the rest of it.

Again, in the native population of the Belgian Congo the disease is increasing not only in the more populous centres but also among the rural communities. Borel has stated that the tuberculosis of the Senegalese is "celle de l'enfant, du singe, ou du cobaye." The tuberculosis of the adult African is a modified primary tuberculosis inasmuch as it has a tendency to become more "larval" than in virgin soil. Professor Lyle Cummins has found this and I think it was he who coined this happily descriptive term.

> "The negro," he says, whatever his type, wherever he comes from, wherever he resides, contacts tuberculosis with extreme facility, and, once phthisical, reacts very unfavourably."

My experience leads me to agree with what Hoebeke has noticed in respect to the disease in Africans and bears out what I have just quoted. He finds in the susceptibility of the American citizens of African descent, even after some hundreds of years racial life on another continent, a proof that the tuberculosis of the African is a special type, depending on African racial peculiarities, and the theory of "susceptibility of virgin soil" will not explain it.

I have spoken of an intermediate or "larval" type—intermediate, that is, between the acute "natural" type and the chronic "modified" type. In natives contracting an antecedent sub-infection the lesions tend to become latent, the defence forces are set to work, and, if the infecting dose be not too great, a certain degree of resistance is acquired. The individual is infected, say in the mines, or in some other industry, his disease is diagnosed in an early stage and he is repatriated. If he can afford to live at ease, doing little, and feeding well, the infection may be checked. He presents no physical signs of active disease, but gives a positive reaction to tuberculin. If a time comes when he can no longer afford to live this easy life, or

when, thinking he is well, he decides to return to work again, with exposure to irritant dusts, and to life in unhygienic surroundings, or if he contracts, say, measles, whooping-cough, or influenza, the old focus may light up, heavy auto- or hetero-infection may occur, and the larval state will be transformed into the "natural" type of disease with its rapid course and inevitable issue.

The latest report from the Gilbert and Ellice Islands in the Western Pacific, contains the following statement :—

"Influenza breaks out without fail after the visit of a ship from the outside world. . . . The large majority of the attacked recover, but there is always a certain percentage of cases of lung sickness adversely affected, which rapidly become acutely ill, have severe attacks of hæmoptysis and die of galloping consumption."

In conclusion: Why are the tropics regarded by many doctors in temperate climates as health-resorts for tuberculous Europeans? I believe there are two main reasons. First, the idea—quite erroneous—that absence or rarity of the disease in certain districts—Rhodesia, Uganda, Kenya, Tanganyika are often mentioned—is due to immunity of the people (the result of climatic conditions), and, secondly, that exposure to the sun's rays kills the bacillus. The former is erroneous, because native races are not immune but highly susceptible, and absence of the disease is due solely to non-introduction of the *causa causans*. The second we need not dwell upon; direct sunlight will not penetrate to a pulmonary focus though it may kill expectorated bacilli.

Looking at the matter from the other side—that of the native: Every consumptive person expectorating the tubercle bacillus is to be regarded as a public menace and, to the negro, a very real menace. Tropical conditions are not always good for the phthisical European. He can, it is true, be more in the open air, but the tuberculous subject is easily fatigued; he avoids the tropical sun, his rooms are shaded to keep them cool, he suffers from loss of sleep, his appetite is capricious and his food less nutritious than at home. Even were it not so, is it not, to put it very mildly, a little selfish to introduce open tuberculous cases among unprotected or even partly protected natives? It is our duty to conserve the health of the natives brought into association with us in the course of industrial and other developments and to avoid, as far as is in our power, the wilful introduction of our chief scourge, tuberculosis.

Discussion.—Dr. MAURICE DAVIDSON said that the study of tuberculosis among tropical peoples was of interest and importance not only as a practical problem of tropical medicine but also on account of the light which it threw upon the pathogenesis of tuberculosis in general.

Of the great prevalence of tuberculosis in the tropics there was no question. The special susceptibility of Africans, Polynesians, Negroes, &c., was well known, and the progress of the disease in India had given rise to much comment. In the U.S.A. the negro race was evidently more susceptible to tuberculosis than the white population; the same was true of the Philippines, where tuberculosis accounted for the greatest number of deaths.

In discussing the pathogenesis of the disease one had to consider three main factors: (*a*) heredity, (*b*) environment, (*c*) infection. With regard to the first of these, although there was no evidence that tuberculosis was a hereditary disease in the ordinarily accepted sense of the word, there did seem to be some ground for the view that in certain outstanding instances the development of acute and rapidly fatal forms of the disease in several brothers or sisters was associated with the inheritance of a type of body-tissue which was especially lacking in the power of resistance to the tubercle bacillus. Such a view was consistent with the laws of heredity as generally understood and accepted. In regard to the second point, he (the speaker) thought that environment was a factor more outstanding in tropical than in European tuberculosis. For example, the greater prevalence of the disease in females in India might well be due to the extremely unhealthy conditions found in the Zenanas. The overcrowding of natives generally and the herding together of many individuals in one small room were predisposing causes which probably obtained very much more than in European

centres, even the worst, and which undoubtedly increased the scope and possibilities of direct contact infection. Climate, which in most European countries could hardly be said to exercise any marked effect upon the incidence of tuberculosis, was of greater importance in the tropics, e.g. as Stitt had pointed out, natives of the sea-level regions suffered more than those of the mountainous districts. In other words, humidity was an important element, tuberculosis being rare in Upper Egypt and in the Sahara.

With regard to infection, he felt that the gradual development of race-immunity, through repeated small infecting doses, was by far the most important cause of the general decline in tuberculosis mortality which had been observed throughout the civilized world in the last half century. Environment probably played a greater part in tropical tuberculosis, in which, apart from relative lack of the race-immunity which was conferred by gradual tuberculization, the severer mortality was in all probability associated chiefly with the more widespread occurrence of massive primary infection. The study of tuberculosis among the native African troops serving in France during the Great War gave valuable information as to the occurrence of two distinct clinical types of the disease. Among the troops from Morocco and Algiers the type was similar to that seen in Europeans. The inhabitants of those areas from which these troops were drawn had undergone tuberculization through contact with white colonists. Among the Senegalese troops and those coming from districts where the disease was not endemic, the type was similar to that induced experimentally in animals or seen clinically in young children, being acute and rapidly fatal, the lesions showing no tendency to fibrosis.

Dr. R. C. WINGFIELD said he would suggest that more attention should be paid to the protective rôle of the lymphatic system in tuberculosis. Allen Krause's experiments had shown that exogenous infection in the guinea-pig was confined to the lymphatic system for a definite period of time and did not become generalized until the bacilli had reached the tracheobronchial glands. Since in many urban populations 900 out of every 1,000 were infected with tuberculosis but only about four of these developed the clinical disease, it was presumable that the remaining 896 might be protected by their lymphatic systems, which held the bacillus a harmless prisoner and prevented its access to the blood-stream. If this was so, the actual site of the exogenous infection was of great prognostic importance. Such a power of the lymphatic system might be an inherited attribute in races which had had a long experience of tuberculosis, and this hypothesis might explain the different responses to infection shown by primitive, recently civilized, and long civilized peoples to which Dr. Scott had alluded.

Dr. H. S. STANNUS said that, so far as tuberculosis in native races was concerned, any provisions made for the exclusion of tuberculous individuals from any particular territory were simply of the nature of a postponement of the evil day which would surely follow in the footsteps of civilization. The only possible means of protecting such populations might be some method of protective vaccination.

The PRESIDENT speaking of the tragedy of tuberculosis as it presented itself in native races said that the introduction of tuberculosis by the white man himself, or the trail of consumption which he left in his wake, could best be followed in the Pacific Islands. One of the most poignant passages in literature was surely Robert Louis Stevenson's description of the spread of tuberculosis amongst the Marquesans—"To judge by the eye," he wrote, "there is no race more viable; and yet death reaps them with both hands. 'The coral waxes, the palm grows and man departs,' says the Marquesan; and he holds his hands."

Section of Psychiatry

President—DAVID FORSYTH, M.D.

[*May* 14, 1935]

The Uses and Limitations of Sterilization in Social Psychiatry

By C. P. BLACKER, M.C., D.M.

[ABRIDGED REPORT.]

ABSTRACT.—The uses and limitations of sterilization in psychiatry have become questions of considerable sociological importance since the publication of the Brock Report in January 1934.

Compulsory and voluntary sterilization have quite different social implications—Psychiatric implications of the German law and of laws which have been proposed or passed in the U.S.A.

Proposals of the Brock Committee; psychiatric aspects of the safeguards proposed; necessity for some general safeguards to prevent abuses.

Genetic results attainable by a vigorously applied compulsory measure as against those to be expected from a voluntary measure.

IN January 1934 was published the Report of a Departmental Committee on Sterilization, appointed in 1932 by the Minister of Health. Briefly, this Report opposed compulsory sterilization but advocated that, subject to certain safeguards, facilities for voluntary sterilization should be made available for certain limited categories of persons.

These recommendations have very important psychiatric implications; they should therefore receive careful consideration by psychiatrists, who, if the recommendations are ever translated into law, would have important responsibilities and duties.

The title of my paper is "The Uses and Limitations of Sterilization in Social Psychiatry." This is a comprehensive title, and at the onset I should like to say that I shall not be able to deal with all the psychiatric implications. It contains, moreover, no reference to the question whether the sterilization envisaged is to be compulsory or voluntary. The omission of this qualification is intentional, since very different psychiatric implications attach to the administration of a compulsory and a voluntary law.

I propose to begin this paper by making a précis of the sterilization law which is now in force in Germany, and of the various measures which have been proposed or passed in the United States of America and to discuss in some detail the proposals put forward by the Departmental Committee on Sterilization (the Brock Committee) in this country. Then will follow a short discussion of the possibilities of sterilization as an instrument of preventive medicine, and I shall then refer to the psychiatric aspects of the plea for safeguards against abuses, particularly those which have been recommended by the Brock Committee.

If we were to grade the measures introduced into Germany and America and suggested by the Brock Report, and consider them in the order of the respect they pay to the wishes, scruples and susceptibilities of the individual, they would fall into the following order:—

(1) Laws such as those proposed by the Municipal Court of Chicago which appoint a State Eugenicist with inquisitorial powers.

(2) The Nazi law, as interpreted by accredited spokesmen, which demands the compulsory notification by all members of the medical profession (except those engaged in research) of persons afflicted with the diseases specified under the Act, and which further provides for compulsory sterilization.

(3) The Californian law, which empowers superintendents of institutions to apply for the sterilization of inmates when these are discharged, but invests no one with inquisitorial powers and exacts no compulsory notification by doctors.

(4) The Brock Committee, about to be considered, which advocates a measure which is purely voluntary in that, according to its recommendations, it will be impossible to sterilize a person against his will.

This précis of the sterilization laws now prevailing in Germany and the United States has been introduced in order to show, by comparison, how extremely cautious and moderate are the recommendations of the Brock Committee.

I will briefly summarize these conclusions and recommendations and will then discuss some of the administrative and psychological problems that arise from them. As was earlier remarked, the Brock committee emphatically condemned compulsion. Among the reasons given for this is the lack of complete certainty as to the genetic result of a given mating from sub- or abnormal parents. The argument is also stressed that any intimation of compulsion would interfere with the administration of the Lunacy, Mental Treatment, and Mental Deficiency Acts, by generating in the minds of the public the fear that by entering an institution they would expose themselves to the danger of compulsory sterilization. But the Committee regarded the case for voluntary sterilization in a very different light, and it is noteworthy that their recommendations in this connexion were unanimous.

They take a view, which has subsequently received critical discussion, that sterilization even when voluntarily sought by a person in full possession of all his normal faculties, is illegal. In brief, they hold that facilities for voluntary sterilization should be made available as a right. They say:

"We were increasingly impressed by the injustice of refusing to those who have good grounds for believing they may transmit mental defect or disorder and who are in every way unfitted for parenthood the only effective means of escaping from a burden which they have every reason to dread. Contraception is no remedy, since we are dealing with people the majority of whom cannot be expected to exercise the care without which contraceptive measures are bound to fail. Nor is voluntary abstinence any remedy. Facts must be faced. It is idle to expect that the section of the community least capable of self-control will succeed in restraining one of the strongest impulses of mankind. The mere suggestion is so fantastic that it carries its own refutation. Without some measure of sterilization these unhappy people will continue to bring into the world unwanted children, many of whom will be doomed from birth to misery and defect. We can see neither logic nor justice in denying these people what is in effect a therapeutic measure."

The categories for which the Committee recommended that facilities for voluntary sterilization be made available were the following:—

(*a*) Persons who are mentally defective or who have suffered from mental disorder.

(*b*) Persons who suffer from or are believed to be carriers of a grave physical disability which has been shown to be transmissible, and

(*c*) Persons who are believed to be likely to transmit mental disorder or defect.

It will be seen that categories (*a*) and (*c*) deal with psychiatric cases. Category (*b*) relating to exhibitors and carriers of grave and transmissible physical disabilities has much less important psychiatric implications.

A very important psychiatric implication of sterilization is the meaning of the term "voluntary" when applied to it. The obvious objection that sterilization can hardly be regarded as a voluntary measure for persons who are certifiable as mentally defective is considered by the Committee. They state that:—

"Many defectives are suggestible, a quality which is by no means confined to defectives, and they will accept the advice of those whom they have learnt to trust. Though they may be incapable of appreciating the sociological implications of sterilization it by no means follows that, from their own point of view, they are incapable of understanding what it means and of making a rational choice. To a large extent this must depend upon the attitude and explanation given by those around them, and this again we believe to be true of other persons in the community besides defectives. Witnesses in immediate contact with defectives stated

that the question was much discussed by the higher grade patients and requests are sometimes made by them for sterilization. It is true that these requests have been inspired by a desire for discharge and in some cases for marriage. We are convinced that the higher grade patients are capable of understanding what they are asking for, and the contention that consent is meaningless is not borne out by actual contact with patients."

It is clear that the word "voluntary" as applied to sterilization has several possible meanings. Sterilization can, in the first place, be sought, sometimes with much urgency, on good genetic grounds by a person who exhibits or carries a hereditary disease or defect. This is how the Brock Committee envisages the performance of the operation in the majority of cases. In the second place, it can be assented to by the inmate of an institution on behalf of whom an application has been made by some person other than himself. According to reports from California, it is in this way that many of the sterilizations are there carried out. Such persons may themselves not particularly wish to be sterilized, but they and their relatives may not think it worth while to go to the trouble and attract the publicity involved in lodging an official protest, and submitting to judicial proceedings in the Courts. The sterilization of such persons is less obviously voluntary. Thirdly, the candidate for sterilization may be so defective in intelligence that he is incapable of giving or withholding consent. The term "voluntary" is not strictly applicable to such a case. But the common denominator underlying the use of the word "voluntary" in these three contingencies is the circumstance that coercion is not forcibly applied. While it is hardly legitimate to say of the last-mentioned group that their sterilization is voluntary in any strict sense of the word, it would certainly be untrue to say that it was compulsory. Much difference of opinion seems to exist upon the ethical propriety of sterilizing people in this group, who are so defective in intelligence that they are incapable of expressing willingness or unwillingness. Certain critics represent this course as a bureaucratically enforced mutilation of defenceless human beings. Others take the view that the loss of reproductive power is no great deprivation for such people, seeing that they do not understand its implications and in any case are totally unfit to become parents. There is no dispute about the inadvisability, on social grounds, of such medium or even perhaps low-grade defectives having children, but there seems to be a difference of opinion on personal grounds. Speaking of this group, the Brock Committee says :—

"It is true of some, particularly of the medium grade, that the validity of their consent would be open to question. But the essence of a voluntary system is that those who object should be free to do so. What matters is that there be no compulsion. So long as there is no unfair pressure and no patient is forced or bribed to consent, it seems to us mere casuistry to discuss how far the patient fully appreciates all the implications of consent."

I now turn to a consideration of the safeguards proposed by the Brock Committee. These will first be discussed serially and then some general observations will be made about the importance of safeguards in general. The safeguards proposed by the Brock Committee are as follows :—

(1) In all cases in which the applicant is capable of giving consent, he should himself apply to be sterilized. An exception is only made when the applicant is not deemed capable of expressing willingness or unwillingness, by reason of mental defectiveness; the application must then be made by his parent or guardian.

(2) Every person applying to be sterilized has to obtain two medical recommendations certifying him as a suitable candidate on one of the three grounds mentioned in the Brock Report. One of these medical recommendations must, if possible, be signed by the applicant's family doctor; the other by a doctor on a list approved by the Minister of Health.

(3) In the event of the applicant being a person who has recovered from a mental disorder, one of the two medical recommendations above mentioned must be signed by a psychiatrist who, in addition to certifying that the applicant is a fit and proper person to be sterilized, must also certify that the operation will have no adverse effect on his mental state. This provision is included because some mental disorders are characterized by obsessions and delusions of a sexual nature which might be aggravated by sterilization.

(4) The applicant's request, together with the two medical certificates must then be forwarded to the Minister of Health whose authorization is necessary before the operation can be performed. In the case of sufferers from mental disorders or defects, the application will be transmitted by the Minister of Health to the Board of Control for their consideration and opinion before authorization is given. In all cases, the authorization will give a time limit within which the operation must be performed.

The Brock Committee recommend certain other conditions, of which the following should be noted:—

(5) The spouse must be *notified* of the application. The Brock Committee considered the question of whether the spouse should be required to give consent to the application for sterilization. They decided in favour of notification only, because it was deemed unfair to give to the spouse a power amounting to that of vetoing the operation.

(6) The operation of vasectomy should not be authorized in the case of any person who has not reached physical maturity, pending the results of further research.

(7) Operations should not be performed in a Mental Hospital or Certified Institution. The object of this safeguard is to prevent the public being led to feel that commitment to any kind of Institution is in any sense a preliminary to sterilization. This attitude is reported to exist in certain States of America in which no defective is allowed out of an Institution unless sterilized, and it also occurs in Germany.

(8) Before a mental defective is sterilized, care should be taken to test his or her fitness for community care, and adequate supervision should be arranged after the operation.

The proceedings must be strictly confidential, and the Minister of Health is given the power to appoint a small advisory committee of experts to which doubtful applications should be referred.

Several important considerations arise from these proposals.

As above stated, the patient's application has to be supported by two medical recommendations, one of which has to be given by a doctor on a list approved by the Minister of Health. The Brock Committee recommends that these "approved" doctors should fall into two groups, one containing psychiatrists, to deal with psychiatric cases, and the other general physicians of good standing to deal with physical diseases or defects. It is recommended that this list should be compiled by the Ministry of Health after consultation, so far as relates to the Psychiatric Section, with the Board of Control. It will be clear that if the psychiatrists and general physicians on this list are to perform their duties adequately, they will require to have a knowledge of human genetics. At present, the number of physicians in this country whose acquaintance with this subject might be regarded as adequate according to a strict standard, could probably be counted on the fingers of both hands. The Brock Committee has recommended that no application should be supported by a doctor *who has not himself examined the patient*. Unless, therefore, long journeys are to be taken by patients or by the physicians on the approved list, the Minister of Health will be compelled to make the list a long one, and in its preparation geographical considerations will take a prominent part. If, then, the recommendations are to be effectively carried out, the subject of human genetics must be more seriously taught in the various medical curricula. The principles of Mendelism are generally included in the medical student's preliminary studies of biology; in addition, the difficulties and limitations of applying them to human material and human pedigrees might be explained during his training in the wards when he sees cases of the diseases in question. In view of the importance which the Brock Committee attaches to the role of the psychiatrist in supporting applications for sterilization, a knowledge of the genetics of mental disorder and defect might be expected of candidates taking the Diploma of Psychological Medicine. And if it were found to be convenient that the doctor in the approved list be a Medical Officer of Health, an arrangement which might solve some of the geographical problems, the subject might also be included in the curriculum of the Diploma of Public Health. It is with profound reluctance that I suggest adding to the mass of knowledge which the unfortunate medical student

and medical graduate is at present expected to assimilate, but I am unable to see how the recommendations of the Brock Committee can be satisfactorily implemented unless some course such as this be adopted.

I have said that the Brock Committee recommends that the candidate's application, backed by the two necessary medical certificates, be considered by the Minister of Health who, moreover, has power to appoint a small advisory committee to guide him in doubtful cases. The Report does not specify how large this committee should be, nor how frequently it should meet. It seems to me of the first importance that this committee should not be too big and should be in a position to meet frequently. Its members will presumably be selected by reason of some special competence whether in animal and plant genetics, medical genetics, psychiatry, medical insurance work, or general medicine. Such people are likely to be busy. Meetings of large committees composed of busy people are difficult to arrange frequently and at short notice, but unless it were possible to call them at fairly frequent intervals, long delays might occur before an application received consideration. This difficulty might perhaps be obviated if decisions could be reached by correspondence. But the problem shrinks in magnitude if we remember that the applications for sterilization will, in the vast majority of cases, be voluntary, in the straightforward and accepted sense, and that in no case will there be a question of bringing coercive measures to bear on a recalcitrant or refractory subject. In these circumstances the responsibilities of such a Committee are very different from those, say, of a German Eugenic Court which ordered compulsory sterilization.

The above remarks apply to the functions and constitution of the medical advisory committee which the Minister of Health would have power to appoint. But the recommendation in question has been criticized on the further ground that it invests the Minister of Health with too much power, and that it is unnecessary to bring him into the matter at all. Of this proposal the usual criticisms which are levelled at bureaucracies and red tape have been made. A timid Minister might veto the majority of the applications; an obstructive Minister might refer the bulk of them to his advisory committee, thereby giving rise to delays; a lazy Minister might pigeon-hole the applications and forget about them, thereby leading the public and the Medical Profession to feel that the safeguards were so complicated and the administration of the provision so slow that it was not worth their while to make the applications at all.

I would now like to say something about what many people regard as the most important of the psychiatric aspects of sterilization, namely how much can be achieved by this measure in the direction of reducing the incidence in the community of mental diseases and defects.

These possibilities, it is obvious from the outset, are limited by the extent to which people will avail themselves of a voluntary measure. If the general public is not educated to the opportunities offered to it or if the safeguards prove too unwieldly, it is probable that only a small fraction of those persons for whom sterilization might be appropriate would come forward and apply for it. The voluntary nature of the measure introduces a quite incalculable factor into any predictions we may try to make.

Allowing for this fact, however, we can try to calculate what could, from a preventive standpoint, be achieved by a really thorough-going application of sterilization to all appropriate persons.

Mental defect.—How much could the incidence of mental defect be reduced by the prevention of parenthood in all appropriate cases? The answer to this question clearly depends upon how much mental defect can be regarded as hereditary. This subject has been very much discussed and widely divergent opinions have been expressed. On the one hand, it has been asserted that about 80% of all cases of mental deficiency are primary, or in other words, attributable mainly to genetic causes; on the other, that a genetic basis can only be *proved* in 10% of cases. By

certain writers, low estimates of the importance of hereditary factors have even been put forward without their having made investigations of the pedigrees of their cases, the decisions as to the importance of heredity being made purely on the basis of the clinical type presented by the defective.

The subject is a complicated one, which there is not time to discuss now; suffice it that investigations of the parenthood of defectives suggest that if the measure were limited to mental defectives, but applied to them in the most thorough-going way, the reduction of the incidence of mental defect in the community in the course of a single generation would probably be somewhere between 5 and 10%. But this result largely depends on where the line is drawn between the certifiable defective and the retarded normal.

A remark made by the Brock Committee is here very apposite. They say :—

"The fact that so many of the parents are border-line cases explains to a great extent the wide variations in the estimate given by various investigators of the proportion of parents who are mentally defective. A slight modification of standard might result in a large increase in the number of persons regarded as mentally defective among these border-line cases. Clinically there is no definite line separating mental defect or dullness."

An investigation, promoted by the Brock Committee, of the *offspring* of mental defectives has very important psychiatric implications. The results of the investigation are set out at length in a supplement of the Brock Report written by Professor R. A. Fisher. Briefly it suggests that the chances are between 4 and 5 in 10 of the offspring of a mentally defective person being mentally subnormal. Allowance has probably to be made here for the fact that the home conditions of the children investigated are below the average. This circumstance is strongly suggested by the fact that no less than 22% of the children in the series had died.

It must be recalled, however, that the Brock Committee want to offer facilities for voluntary sterilization, not only to persons themselves certifiable as mentally defective, but also to persons who, though not themselves defective, are deemed likely to transmit mental defect to subsequent generations. A very good instance of how this can happen is the shocking case quoted in Appendix No. II of the Brock Report. It is of a sibship of seventeen, of whom five had died; of the remaining twelve living children, no less than eight were mentally defective. An interesting and important feature of this case is that according to the Report, neither the father nor the mother were themselves certifiable as defective though the paternal grandfather was mentally defective and two great-uncles were certified as insane.

It is impossible to foretell to what extent sterilization will be sought by such subnormal carriers; this much is certain, however, that they are far more frequently the parents of mental defectives than are persons who are themselves defective. It may, in the long run, transpire that, when judged from a preventive standpoint, sterilization has more value when applied to the carriers than to the exhibitors of mental defect.

Insanity.—Of the psychoses which have been investigated in this connexion, manic-depressive insanity shows the most obvious hereditary features. According to the investigations of Rüdin, one-third of the children of a mating between a manic-depressive parent and a normal parent become manic-depressive, and another sixth will exhibit cyclothymic features not amounting to a psychosis. If both parents are manic-depressive, two-thirds of the children will exhibit the disorder and the remaining third will exhibit cyclothymic traits; in short, all the children of such matings are either severely or mildly affected.

Hereditary factors in schizophrenia are less marked. According to Rüdin, there results, on average, from the matings of schizophrenic with normal persons, 10% of schizophrenic children and an additional 30 to 40% of schizoid psychopaths, making a total of 50% of offspring severely or mildly affected. When both parents are schizophrenic, about 50% of the children are schizophrenic and about 30% schizoid psychopaths, making a total of 80%. Analogous percentages for the incidence of

psychoses or psychopathy have been worked out for grandchildren, cousins, nephews, and nieces. It is difficult to estimate in numerical terms the incidence of these psychoses in England and Wales. In and around Munich, manic-depressive insanity, as there diagnosed, occurs in 0·4% and schizophrenia in 0·8% of the population. This makes a total of 1·2%, and if a similar incidence obtained here, there would be some 480,000 persons afflicted with these two disorders in England and Wales. In view of the variable incidence of mental disorder in different parts of the country, however, it is by no means certain that this is an accurate estimate.

Hereditary factors have also been described by German writers as playing a part, though a less definite one, in the production of the paranoid constitution, of criminal propensities, of senile dementia and of arteriosclerosis; and it is probably the experience of every psychiatrist that, among the relatives of psychoneurotics, are to be found a higher proportion of socially ill-adapted and unstable persons than occur, on average, in the families of normal persons. But obviously environmental factors play some part here.

The literature on the importance of hereditary factors in idiopathic epilepsy has recently been summarized by Russell Brain. He concludes that the probability of direct transmission from an affected parent to his child, is as one in ten, or the same as is estimated by Rüdin for schizophrenia.

I have perforce dealt very cursorily with the enormous subject of the importance of heredity in the causation of mental defect and disorder. The literature, already considerable, is rapidly expanding. Much fruitful investigation might be carried out in this country and it seems probable that our knowledge of this subject will grow quickly in the near future.

Marriage of defectives.—Before returning to the question of safeguards, something should be said about sterilization and the marriage of mental defectives. For a long time, the legal prohibition of the marriage of mental defectives has been advocated by influential organizations and persons. Thus it was urged in successive reports of the Board of Control between 1927 and 1931 and also by the Wood Committee; also the proposal was recently put forward in the House of Lords by Lord Kilmaine. Strangely enough, it has been vehemently defended by persons who have opposed the legalizing of sterilization on the grounds that this measure would be followed by an increase of promiscuity and a spread of venereal diseases. Advocates of sterilization have, on the whole, taken the view that, on grounds of social justice and social hygiene, it is better to permit the marriage of mental defectives, provided that one or both have been sterilized, than to prohibit their marriage. The State of Nebraska has just adopted a revision of its sterilization law according to which a register must be kept of all persons who have been legally adjudged feeble-minded. An up-to-date copy of this must be kept in the office of each County Clerk and a marriage licence will not be issued to any person whose name is on that list unless evidence is furnished of prior sterilization. Such a provision, however, has been criticized on administrative and religious grounds. On administrative grounds, it has been pointed out that it is more difficult to deal with a married than with an unmarried defective under the Mental Deficiency Acts, and on religious grounds it has been urged, notably by Dr. Letitia Fairfield in an ably written pamphlet published by the Catholic Truth Society, that the encouragement given by legislation to such a practice would lower the conception of marriage in the community.

In the course of the last five years I have received numerous letters and requests from people who wish to be sterilized. Some of these have been submitted by persons for whom this operation would, in my opinion, be in the highest degree inappropriate.

I will give three examples: A young man of 23 recently asked me to have him sterilized. When pressed for reasons, he became evasive and beat about the bush. Finally it came out that he and his fiancée were ardent socialists and pacifists, were convinced that a European war was imminent and were averse to having children

who would, he said, be blown to pieces, gassed, tortured, and starved. At the beginning of the year I was asked by a girl of 24 if I could arrange to have her sterilized because of insanity in her family. It transpired that the only case of insanity occurred in a grandparental sibship of 8. No other insane person occurred in the very considerable pedigree of her family, comprising, it transpired, over 100 people. The girl had heard a lecture in which the begetting of hereditarily tainted children was depicted as a crime and had jumped to the conclusion that the considerations stressed by the lecturer applied to her. It is unnecessary to stress to this audience the fact that mild degrees of anxiety are extremely common to-day; and that the anxiety can embody itself in one of a multitude of different fears. One of these has been much forced upon my notice, namely the fear of procreating children afflicted with hereditary disease. The thought of this possibility has probably occurred some time to a majority of the mothers and fathers of children before their birth. The presence of an abnormality in the pedigree, even if the afflicted person be a very distant relative, can, in a subject predisposed to anxiety, condense this vague apprehension into a very definite fear. Lastly I have had the experience of a young man asking me to get him sterilized because a remote relative of his fiancée had committed suicide, for which reason, the latter, a woman aged 23, wished the marriage to be childless. The young man desired to take advantage of the simplicity of the operation of vasectomy, as compared with that of salpingectomy, by mounting the operating table instead of her. He proposed to get himself sterilized secretly, and then joyfully to appear before her announcing that, by this gesture of self-abnegation, he had overcome her scruples and difficulties. But before this could be done it turned out that the girl was not keen on marrying him, and had put forward the story of the suicidal relative as an excuse to get out of it.

Such experiences, and others which I could mention, have led me to believe that safeguards are necessary to prevent people from getting themselves sterilized only to regret it bitterly at a later stage of their lives. The operation of vasectomy is a very simple one, capable of being performed under a local anæsthetic, and requiring but a few hours' absence from work. It must further be recalled that this operation is probably irrevocable. The vas deferens is a very small tube, which must be difficult to sew together after a lapse of years. There is, moreover, evidence for the view that even if the testicular end is not ligatured, it cicatrizes spontaneously, thus leading to an atrophy of the spermatogenetic cell.

Abuses of the operation of vasectomy would it seems to me, be inevitable unless this measure were somehow safeguarded; abuses of the operation of salpingectomy would, in my opinion, be less likely to occur—by reason of its seriousness.

I now come back to the final safeguard proposed by the Brock Committee, namely the authorization of the operation by the Minister of Health. This measure has, as above remarked, been criticized as a bureaucratic infringement of the liberties of the individual. What then would be the result if it were dispensed with—if, that is, it were made possible for a person to get sterilized on the basis of two medical recommendations and nothing more? Surely abuses could very easily arise, and I would submit that some central authority should be made finally responsible for the proper administration of the Act. I can well see the difficulties which are raised by investing a Government Department with such power, but it seems to me that they are less serious than the abuses which would arise if this safeguard were omitted.

In conclusion, I would like to repeat what I said at the outset, that I have not been able to deal with all the psychiatric implications of this subject. I have said nothing, for instance, about the psychological effects of vasectomy and salpingectomy, and little about the numerous administrative problems which would arise in connexion with the Mental Deficiency Acts. These points, however, may be raised in discussion.

Section of Orthopædics

President—ALAN H. TODD, M.S.

[*April* 2, 1935]

Synovectomy for Multiple Synovial Chondromata.—J. P. HOSFORD, M.S.

Patient, female, aged 23. In 1927 she had noticed a swelling of the right knee, which had been sudden in onset. She had rested in bed for two months with slight improvement. The swelling had been associated with pricking pain.

On examination.—March 1931: She was a healthy girl. There was a considerable swelling of the right knee with signs of fluid in the joint, which was tender. Palpation of the joint gave a peculiar crepitant sensation. Skiagrams of the joint showed no abnormality. The joint was explored and 764 white irregular

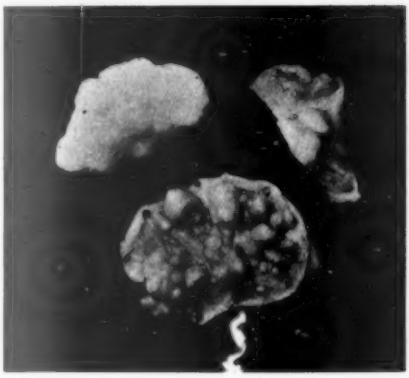


FIG. 1.—Top left: one of the many loose chondromata. Lower: multiple small tumours attached to synovial membrane.

cartilaginous loose bodies were removed. Following this, the size of the joint and its range of movement were almost normal, but occasionally the knee locked.

August 1931: The joint was more widely opened and about 50 similar loose bodies were seen to be attached to the synovial membrane and apparently growing from it (fig. 1). These chondromata were excised with a portion of surrounding

synovial membrane. She was well for some months after this, but again the knee began to lock, and in May 1932 the knee was opened by a long curved internal incision and a synovectomy was performed. The patella was dislocated laterally and the whole of the synovial membrane was dissected away from the anterior part of the joint. Through the same incision the posterior part of the joint was opened behind the internal lateral ligament. Several chondromata were found and the synovial membrane was dissected away.

Convalescence was prolonged; there was a great deal of pain and recovery of movement was slow.

FIG. 2.—Double exposure photograph showing range of movement of right knee.

Present condition.—No symptoms. Patient can walk six miles. Range of movement from 180° to 80° (fig. 2). There is a hypersensitive area between two scars.

Old Un-united Fracture of Tibia with Overgrowth of Fibula.—S. A. S. MALKIN, F.R.C.S.ED.

A. W., aged 36, stated on February 1, 1925, that seventeen years previously he had had a fracture—apparently compound and comminuted—of the leg. After six months' treatment he returned to work and had continued to work since then, wearing a double short iron. He had been able to continue his work until five weeks previously, when the leg suddenly let him down.

On examination.—He was found to have an un-united fracture of the lower third of the tibia and scars on the medial and lateral aspects. There was bowing of the leg.

A skiagram shows a gap in the tibia and considerable overgrowth of the fibula, which is bowed.

Un-united fracture of the tibia with compensating overgrowth of the fibula (Mr. S. A. S. Malkin's case).

Two Cases of Congenital Dislocation of the Hip occurring in the same Family.—B. WHITCHURCH HOWELL, F.R.C.S.

(I). L. B., male, aged 4 years. Congenital dislocation of the left hip.

Closed reductions failed. Open reduction with new roof to acetabulum, May 1934.

Present condition.—Hip stable; no limp; no shortening. (*See* skiagrams, figs. 1 and 2, p. 66.)

(II). S.B., female, aged 3 years, sister to L. B. Congenital dislocation of both hips.

Right easily reduced and easily redislocated; has just had third reduction in Fever Hospital.

FIG. 1.—L. B.: congenital dislocation of hip. Before reduction.

FIG 2.—L. B.: congenital dislocation of hip. After open reduction and formation of roof to acetabulum.

From past experience and from the experience gained in the case of her brother, L. B., open reduction and formation of a new roof to the acetabulum seem indicated.

The following cases were also shown:—

D. McCRAE AITKEN, F.R.C.S.Ed.—**Congenital Scoliosis.**

C. LAMBRINUDI, F.R.C.S.—**Old Perthes' Disease Associated with Scoliosis.**

H. J. SEDDON, F.R.C.S.—**Plastic Operation for Injury of Leg.**

R. FURLONG, F.R.C.S.—**Scoliosis of the Spine due to Spasm of Lumbar Muscles.**

N. CAPENER, F.R.C.S.—**Synovial Chondromatosis Treated by Synovectomy. Traumatic Arthritis of the Knee Treated by Synovectomy.**

A. ROCYN JONES, F.R.C.S.—**Painful Hip: for Diagnosis.**

[*May* 7, 1935]

Synovectomy of Knee for Chronic Synovitis Following Trauma.—L. H. F. WALTON, L.R.C.P., M.R.C.S.

Miss L. B., aged 17, while working as a waitress in Christmas 1931, fell on the stairs, injuring her right knee. The knee was painful at the time, and the pain continued, but there was no gross disability. Synovitis gradually increased over three months, until she was unable to continue work. Iodine and antiphlogistine were applied, but the synovitis still increased until June 1933.

June 1933: Sent to hospital on account of pain and swelling of the right knee. Synovitis very marked. Physical treatment given.

July 1933: No improvement. Skiagram normal. Range of movement almost full. Slight wasting of quadriceps.

Wassermann reaction negative; no focal sepsis discovered. Physical treatment continued: heat, faradism, massage.

Some progress, but condition not cleared up.

November 1933: Fluid still present; discomfort less.

June 1934: Fluid never cleared; now increasing again. Physical treatment continued: diathermy, ionization, counter-irritation by means of mercury-vapour lamp, &c. Still no improvement.

September 1934: *Operation*: Synovectomy of right knee (extensive but incomplete).—Synovial membrane found to be much thickened and swollen and markedly injected, particularly on the inner and front aspects of the internal condyle and the suprapatellar pouch.

After-treatment.—After ten days, movements in bed were begun; pulleys used. Kept off weight for two months.

Diathermy given for three months from the end of the second month.

Result.—Range of movement from 180° to 130°. No pain. Back at work.

Synovectomy of Knee for Chronic non-traumatic Synovitis.—L. H. F. WALTON, L.R.C.P., M.R.C.S.

Mrs. P. D., aged 25. First seen in August 1933. She gave a history of five years' intermittent synovitis of the left knee. Skiagrams showed no abnormality. Range of movement was full. Physical treatment ordered. Knee improved.

July 1934: Recurrence of synovitis after a few weeks, and had been intermittent ever since. Physical treatment resumed.

September 1934: *Operation*: Synovectomy of left knee. Movements with pulleys started after seven days in bed. No weight for six weeks. Diathermy.

November 1934: 20 to 30 degrees of flexion. Mobilization was attempted, under an anæsthetic, but the joint was so firm that no increase of movement was obtained. Diathermy continued. Movements gradually increased to 60 degrees. Still improving.

Generalized Osteitis Fibrosa. Rapid Recalcification of Bone After Complete Parathyroidectomy.—R. BROOKE, M.S.

Since the work of Hunter, Turnbull and others, many cases of generalized osteitis fibrosa associated with hyperparathyroidism, and cured by the removal of a parathyroid tumour, have been described. The following case presents some unusual features.

History.—The patient, a woman, aged 42, first came to hospital in April 1934, complaining that for some months she had noticed that her back was becoming bent. She was found to have a general kyphosis, and an X-ray examination showed rarefaction of the vertebral bodies.

The provisional diagnosis of senile osteoporosis was made, and the patient was fitted with a spinal support with double pelvic bands, lateral steels, and arm rests. Three months later she returned to hospital complaining of weakness and wasting of the right hand. This was thought to be due to pressure of the arm-rests on the brachial plexus. The lateral steels bearing the arm-supports were therefore lowered, and the arm was placed in a sling.

Three weeks later she gave the history that a few days previously her hand had slipped accidently out of the sling, causing very severe pain in the little finger, which had since been swollen. The finger when examined was found to be swollen and enlarged, and a skiagram revealed a pathological fracture of the fifth metacarpal bone, and generalized rarefaction and cystic degeneration of the bones of the hand and wrist. The other bones of the body were then examined by X-rays, and pathological fractures of both clavicles were demonstrated, together with cystic changes, as in the bones of the hand. It was now quite clear that the upturned anterior ends of the arm-rests had, by pressure, produced a pathological fracture of both clavicles, and that the brachial plexus paralysis on the right side resulted from the pressure of the fractured fragments of the clavicle, rather than from the direct pressure of the arm supports themselves.

By this curious accident the diagnosis of generalized osteitis was established. The bones of the skull, forearm, feet, leg, and pelvis all showed similar cystic changes. The blood calcium was 16·8 mgm., and a few days later 17·8 mgm. (normal 6-12 mgm). The general condition of the patient was good. There were no symptoms. Some excess of body pigmentation was observed, resembling that produced by deep sunburn. There was no visible or palpable tumour in the region of the thyroid gland.

Operation.—On November 14, 1934, under local anæsthesia, and through an ordinary collar incision in the neck, the thyroid gland was exposed. The usual sites of the parathyroid bodies were explored, but no tumour was found. It was thought that the tumour might be embedded in the thyroid tissue so, on that assumption, the whole of the right lobe of the thyroid gland was removed, together with the isthmus and one half of the left lobe. Subsequent microscopical examination of the excised tissue showed the presence of normal thyroid and parathyroid tissue only; there was no tumour tissue.

The failure of the operation was explained to the patient, and it says a great deal for her courage that she agreed to return after an interval for further operative treatment.

On her re-admission to hospital the pigmentation was deeper. The blood calcium was 17·3 mgm. and the blood phosphorus 1·17 mgm.

On January 19, 1935, with intratracheal anæsthesia, and through an incision lower in the neck, a much more thorough exposure was made than on the previous

occasion. The sternal heads of both sternomastoids were detached from their origins and thrown outwards, the trachea and œsophagus were rapidly exposed, and the remaining half of the left lobe of the thyroid was inspected. As no tumour could be seen or palpated, the whole of this thyroid tissue was removed with the exception of a small portion on the inner and posterior surface. Naked-eye examination of the tissue removed showed no obvious parathyroid tissue, and it was concluded that the tumour was aberrant in position. The œsophagus was lifted forwards, and the prevertebral region on each side was explored without success. Lastly attention was directed to the superior mediastinum, and in this situation lying well down beneath the innominate artery and a little to the right of the mid-line a rounded parathyroid tumour was at once identified, freed from its loose connexions, and removed with ease.

The tumour measured nearly three-quarters of an inch in diameter, was yellowish-brown in colour, and on microscopical section was seen to be made up of the usual typical dropsical oxyphil polygonal cells.

After-treatment and progress of case.—The recovery of the patient was watched with considerable anxiety, for it was almost certain that all the parathyroid tissue had been removed, and unless a parathyroid gland existed in an aberrant position tetany was likely to occur. On the fourth day after operation the patient suddenly developed marked carpopedal spasm. Trousseau's, and Chvostek's signs were positive. There was alarming spasm of the diaphragm, with cyanosis. The blood calcium dropped to 8·4 mgm., the blood phosphorus was 3·2 mgm. It was only by repeated intravenous injections of calcium gluconate in 2-gram doses that the spasm was controlled. From this time onwards the attacks of tetany followed one another in rapid succession. The patient was irritable and unbalanced; on occasions she was violent and threw plates across the room and struck the nurses. She refused to eat, and when not actively aggressive, lay for considerable periods lethargic and dumb. At times she evinced cravings for strange foodstuff, such as herrings and cream, both of which she was allowed, and ate with great relish. The attacks of tetany often took place in the night, with alarming breathlessness and fainting.

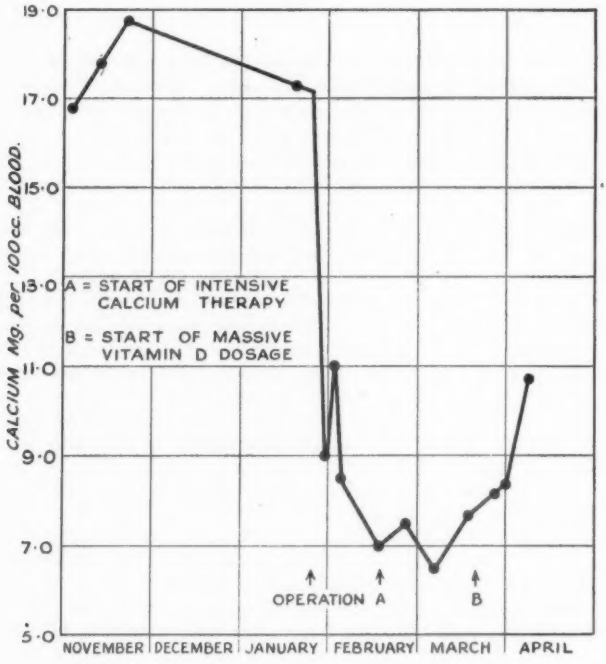
The patient was now receiving 250 gr. of calcium lactate orally, and 2 grm. of calcium gluconate intravenously, each day, as well as two litres of milk and 100 c.c. of $\frac{1}{3}\%$ hydrochloric acid. In all she was receiving about 2,000 units of vitamin D. In spite of this it was with the greatest difficulty that the blood calcium was kept above the level at which tetany supervened. In her case this was about 8·5 mgm.

At this point, through the courtesy of Messrs. Glaxo Ltd., who kindly supplied the material, massive doses of vitamin D (AT10) 50,000 units—as against the previous dose of 2,000 units—was administered orally as calciferol (vitamin D in olive oil) in dram-doses daily, together with calcium gluconate 2 grm., also administered orally.

From the commencement of this therapy the patient began to improve (*see* chart, p. 70) the mental symptoms all disappeared; she became brighter, put on weight and was soon a comparatively normal individual. Her blood calcium rose to 12 mgm. and has remained at this normal level ever since, with diminishing doses of vitamin D and of calcium.

The interest of this case lies in the fact that it has been found possible to keep a patient with tetany and who has presumably lost all her parathyroid tissue, alive and well by the oral administration of calcium with massive doses of vitamin D. There is reason to believe that this therapy may be continued indefinitely, and without intolerance or discomfort to the patient. Moreover, once the blood calcium has been raised to a normal level, the frequency of administration of the calcium and vitamin D may be diminished, and the dose also reduced.

Secondly, as a result of the loss of parathyroid tissue, and in spite of the low blood calcium there has, as a result of the administration of large doses of calcium,



been an enormous recalcification of the bones. Thus a skiagram taken only thirty-eight days after the operation and the commencement of calcium therapy, shows a remarkable restoration of their calcium content.

Scoliosis associated with von Recklinghausen's Disease : Treated by Bone-Grafting.—NORMAN CAPENER, F.R.C.S.

Miss U. O., aged 15½, first seen in March 1933, with a history of gradual onset of scoliosis following a fall from a height of 6 ft. on to her back four years previously. She had been under a variety of practitioners (orthodox and unorthodox), but to Dr. Byam belongs the credit of recognizing the associated evidences (not very marked) of von Recklinghausen's neurofibromatosis—subcutaneous nodules, areas of pigmentation and retarded mentality. Other medical men saw the patient and the general view was that the bones were brittle and that this condition had caused a curve for which nothing much could be done.

The patient had not previously been seen by an orthopædic surgeon, and my view was that there was no evidence of a generalized bone disturbance such as generalized osteomalacia. The condition was a local one, either neurotrophic or vascular in origin, in the latter case resembling Kummel's disease. I took the counsel of two of my senior colleagues who agreed essentially with my viewpoint.

Remedial gymnastics and corrective plasters were applied, but in view of the failure to maintain actively the correction thus obtained, the spine, at the site of

maximum curve in the dorsal region, was fused by the multiple tibial bone-graft method on April 19, 1934 (*see* skiagram).

This is the first recorded case of severe structural scoliosis, associated with von Recklinghausen's disease, treated by bone-grafting. The operation was undertaken

Skiagram of spine after grafting. Note cystic areas in vertebral bodies. Grafts outlined.

in order to prevent the severe deformity which may be found in this condition and which in the present case was steadily developing, in spite of conservative treatment. I believe that this treatment is justified, not only for this reason, but because any deformity must be regarded as neurotrophic in origin rather than as due to the essential defect of bone-formation.

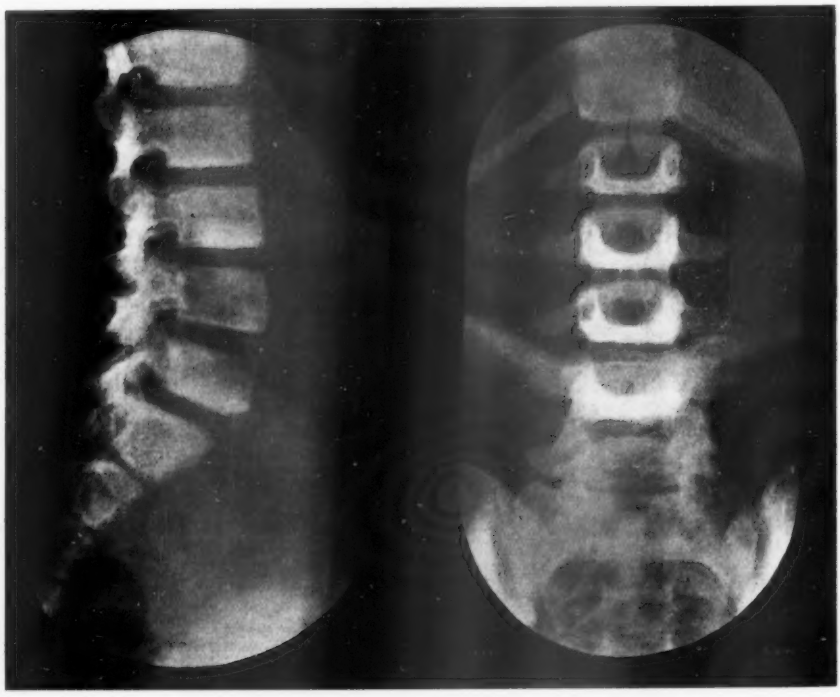
Skiagrams of a Very Early Case of Spondylolisthesis.—NORMAN CAPENER, F.R.C.S.

These skiagrams are of the lumbar spine of a small boy, aged 7 years and 10 months, when first seen by me April 30, 1934.

They are shown because at the time of the publication of my article on "Spondylolisthesis" (*Brit. Journ. Surg.*, 1932, xix) the earliest case of which I

could find record in the literature was that of a girl, aged 11, reported by Myerding (*Journ. Bone and Joint Surg.*, 1931, xiii).

On examination.—The child was of rather frail type and had poor posture. There was clinical evidence of spina bifida occulta in the upper lumbar region and some prominence of the sacrum, with lordosis above.



Skiagrams showing forward displacement of body and break in pedicles of 5th lumbar vertebra with spina bifida occulta of 12th dorsal and 5th lumbar vertebræ.

The child is a relative of a distinguished physician abroad, and since I made the diagnosis of early spondylolisthesis he has been seen by a variety of physicians and surgeons. These include one of the senior members of this Section, who agrees with my diagnosis. The general surgeons and physicians tend to deny it.

The following were also shown:—

PHILIP WILES, M.S.—**A Case of Dorsilumbar Kyphosis in a Girl aged 21: for Diagnosis.**

S. A. S. MALKIN, F.R.C.S.Ed.—**Skiagrams showing a Late Stage of Osteochondritis of the Spine. Skiagrams of a Case of Kienbock's Disease of the Semilunar Bone.**

Section of Otology

President—E. A. PETERS, F.R.C.S.

[*May* 3, 1935]

Some Practical and Theoretical Points in Labyrinthology

By Dr. GÖSTA DOHLMAN (Lund)

ABSTRACT.—The work of Steinhausen in Greifswald on the function of the cupula (*Pflüger's Archiv*, 1933, Band 232, Heft 4) is of extreme value in the conception of the physiological mechanism of the labyrinth. Extension of this work by measurement of the exact relationship between the movements of the endolymph in the canals and the bending of the cupula. Demonstration by means of pictures, etc.

Comparison of the three methods of examination of the peripheral labyrinth. The time of the post-rotational nystagmus, the duration of the nystagmus after applying a constant pressure to a fistula, the time during which the caloric nystagmus continues after changing position of the head from Brüning's optimum to minimum position—all are comparable quantities and are times of about the same length, and all seem to be due to the elasticity of the cupula.

The galvanic reaction: why it does not give practical results: the theory and technique of chronaxiemetrie: a new method of obtaining an exact estimation of the chronaxie of the vestibular nerve and the possibility of the practical use of this method.

Demonstration of apparatus for determining the vestibular chronaxie, and of instruments for the exact registration of the eye-movements during nystagmus.

IN 1874 Mach, Breuer, and Crum-Brown made the suggestion that fluid currents of the endolymph were the essential stimulus for the epithelium of the crista ampullaris. This was the first step to a more physical conception of the function of the labyrinth, as distinguished from an earlier physiological point of view, based more on theory than supported by facts.

In the sixty years that have passed since then, an enormous amount of work has been done in investigating the mechanism of the labyrinthine functions. This work has been well justified since it is obviously important for us to know, with detailed certainty, the physiological functioning of the labyrinth, in order to decide as to the value and scope of our methods for its examination. And we must also have a firm physiological basis, if we are some day to be able to distinguish the functions of the peripheral organ from those of the central nuclei.

When the theory of endolymph-current was advanced, it was thought—and it is still sometimes thought—that during a head-turn or a multiple rotation, the endolymph-current in the semicircular canals went on as long as the vestibular reactions lasted. But the labyrinth is a very small organ with minute capillary canals, so that there was great difficulty in obtaining an acceptable correspondence between the current-theory of relatively large and lasting fluid movements, and their physical unlikelihood. This brought about fresh—physically, still less likely—hypotheses, e.g. those presuming a pressure effect to be the stimulating agency (Biehl, Wittmack).

When Gaede physically calculated what amount of endolymph-movement was possible, he proved that so powerful a stimulus as 10 revolutions in 20 seconds cannot produce a fluid current for longer than about $\frac{1}{10}$ second. Direct observations on models made by Maier and Lion, proved that movement of the fluid took place during and after rotation, but they were of too short duration for measurement by

direct observation. The difficulty remaining was to explain the mechanism of a nystagmus lasting as long as from 15 to 45 seconds caused by a movement in the endolymph during only parts of a second. Bárány tried to explain this as a result of central reactions, Maier and Lion as dependent on chemical processes; others avoided the question. But until such a main point in our conception of the function of the labyrinth has been brought into correspondence with known facts, we are building very insecurely in our attempt to distinguish the central and peripheral factors during stimulation.

First, turning to the peripheral organ, we must ask what mechanism transmits the stimulus from the fluid-current to the neuro-epithelium. From an illustration in any histological description of the labyrinth (fig. 1) we get the impression that the cupula from the crista extends into the lumen of the ampulla at most perhaps half its section. With a current from the canal into the ampulla after a rotation of 10 revolutions in 20 seconds, there is, according to Gaede's calculations, a movement

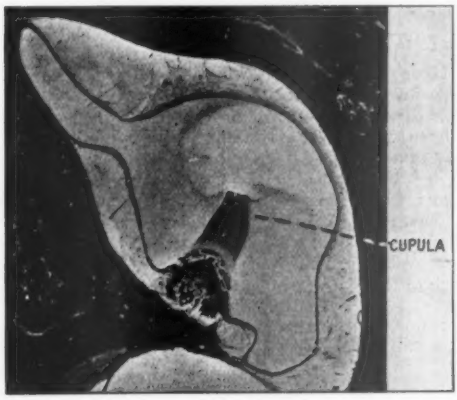


FIG. 1.

of the endolymph in the canal of at most $\frac{1}{2}$ mm. In the ampulla, as a result of its 10-times greater width, there can occur a movement of, at most, $\frac{1}{20}$ mm. Naturally, from this, one gains the impression that the current from the canal would lose itself like a streamlet in the great lake of the ampulla, without any noteworthy effect on the insignificant cupula. Therefore we must ask: (1) Is this picture of the cupula correct? (2) Is the relation between the sections of the canal and the ampulla really as large as 1:10?

The first question is answered by the investigations of the function and morphology of the cupula, published during recent years by Professor Steinhausen of Greifswald, who showed that by introducing a contraster, e.g. indian ink, into the endolymph, the cupula could be made visible in unstained dead, or even living, animals. This can be demonstrated from one of my preparations made from a fish, according to the methods described by Steinhausen (fig. 2).

As seen in this way, the cupula actually fills the ampulla from the crista to the opposite walls. Every movement of fluid in the canal must then unconditionally cause a movement of the cupula. By this means we get a corresponding stimulus in the neuro-epithelium, probably in the same way as we get it through the disturbance of other similarly built sense-organs, e.g. in the skin. From this we have plain evidence (1) That endolymph-movements caused by rotation of caloric

stimulation can occur in the canal as previous investigations have shown; and (2) that they can displace the cupula. By experiments on living fishes, Steinhausen has shown that the bending of the cupula gives vestibular eye-movements, and thus really forms the essential means of stimulus for the neuro-epithelium. By this the Mach-Breuer and Crum-Brown hypothesis is corroborated in principle, and the function of the semicircular canals explained.

The second question is the relation between the cross-sections of the canal and the ampulla. The canal cross-section, as I have just indicated, is only one-tenth of the cross-section through the ampulla, according to the measurements of Biner Wulf and others. From this we conclude that the movement of fluid in the canal must be ten times as great as the endolymph-movement or cupula-movement in the ampulla can be. The difficulty is, then, in seeing how an endolymph current large enough to stimulate the neuro-epithelium in the ampulla can take place in these fine capillary tubes of the canals. By Steinhausen's method, however, we can see to what extent the cupula follows the movements of the endolymph. From a little opening in the wall of the membranous canal, the lumen of the canal and the ampulla is filled

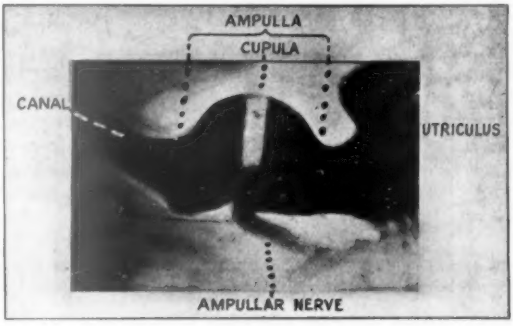


FIG. 2

with the black fluid from indian ink introduced into the canal, but it stops at the cupula, which then appears as a transparent formation stretching from the crista to the opposite ampullar wall. With a glass capillary I have introduced a little drop of oil into the canal (fig. 3). The drop lies like a transparent pearl occupying the canal lumen. In this way the fluid movements in the canal and the displacement of the cupula can be followed together. As is apparent from the figures, an endolymph displacement of 1, 2 mm. causes an angular change of position of about 40° in the cupula.

Again, we know that a fluid movement in capillary canals like those of the labyrinth, after a rotation, cannot last longer than the fraction of a second, because the inner friction, the viscosity of the fluid, in these minute capillaries prevents a longer-lasting movement. And yet after rotation we have a nystagmus and other vestibular phenomena of stimulation that last about half a minute.

By his experiments on living animals Steinhausen has shown to what this is due. Two of his results are of importance here: (1) That a brief displacement of the cupula occasions only a deviation of the eyes, but a longer-lasting displacement causes a nystagmus. (2) That after displacement—for example during or after rotation—the cupula slowly resumes its initial position through its own elasticity, and at the same time the nystagmus gradually decreases and stops. This displacement and elastic return of the cupula explains why a post-rotatory

stimulation lasts longer than the stimulating endolymph current, which only can bring about the cupular displacement.

Which mechanism occasions the movement of the endolymph during and after rotation? The only thing that can affect the endolymph during a rotation is the

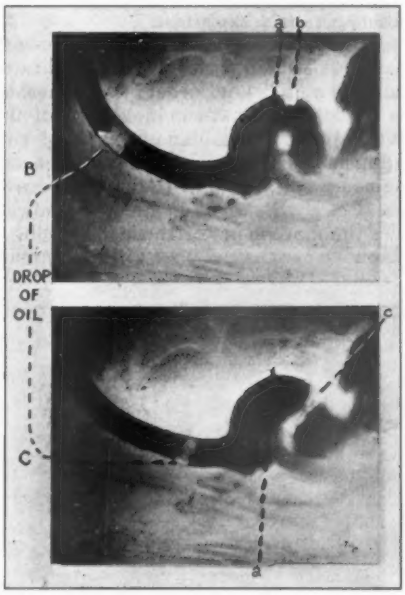


FIG. 3.

a. Piece of hair showing the initial direction of the cupula.
b. Initial position of the cupula.
B. Initial position of the drop of oil in the canal.
c. Forced position of the cupula due to the movement of endolymph.
C. Second position of the drop of oil due to the movement of endolymph.

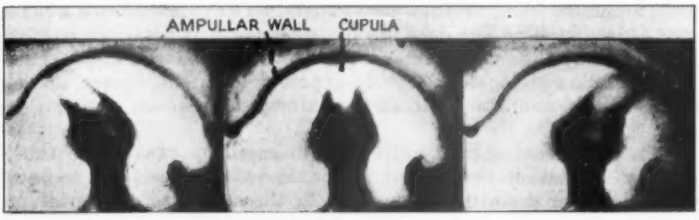


FIG. 4.

Through the courtesy of Professor Steinhausen one of his films was shown at the meeting. The above pictures (figs. 3 and 4) are taken from this film, and show the different positions of the cupula during vestibular reactions.

inertia of the fluid, acting during increase or decrease of rotational speed, i.e. an acceleration or retardation of the movement—but not rotation at even speed, although during a brief turn of the head there is no post-rotational nystagmus, even if the alteration in speed is considerably greater with an ordinary quick turn

of the head than with our usual experimental stimuli. This must be due to the fact that in turning the head we get a swift deviation of the cupula, and thereby a deviation of the eyes; and as a result of the retardation we must get a movement of the cupula in the opposite direction, and a deviation of the eyes also in this same direction. By this means the cupula and the eyes return to their starting point. But if we continue a rotation for a longer period, as in the usual rotation test, we have to imagine the reaction in the following way:—

The cupula deviates during, perhaps, the first, or possibly also the second, revolution as long as the rotation is accelerated. On reaching a constant speed the rotation surely no longer affects the fluid or the cupula in any way. The deviation of the cupula is now, however, gradually diminished by its elasticity; and after about half a minute it has returned to the original position. It is to be expected that the nystagmus *during rotation* should cease when the cupula resumes its normal position, and it does, as Buys showed by nystagmographic registration several years ago.

When rotation stops we again have, as a result of the effect of retardation on the endolymph, a deviation of the cupula, this time in the opposite direction. A post-rotational nystagmus occurs, and lasts as long as the cupula needs to return once more, through its elasticity, to its starting position. This explains why a post-rotatory nystagmus does not occur until after a longer continued rotation. And it explains why we must have a rotational time of about twenty seconds to obtain the longest nystagmus for any rotational speed. For the cupula has by that time regained its initial position by its elasticity, so that it might be ready for the maximal displacement in the opposite direction through the inertia of the endolymph when the rotation ceases. So the nystagmus *during* rotation, like the *post-rotational* nystagmus, is a consequence of the deviation of the cupula; and its duration depends on the time the cupula requires to reassume its normal position.

From this it will be expected that as Buys, Grahe, Maier, Lion, and others have shown, the nystagmus should have the same duration both during and after the rotation.

We may conclude from this that the rotation test cannot directly gauge the sensitiveness of the vestibular apparatus, or measure its reactive capacity. The time for the post-rotatory nystagmus that we measure in the rotation test is primarily related to the elasticity of the cupula. This by no means directly corresponds to the susceptibility of the end-organ or the central nuclei.

But these deviations of the cupula and its elastic return are characteristic not only of the rotatory stimulus. In the nystagmus by pressure, as in the fistula test, the following is found: If a constant pressure is applied to the fistula of, e.g. the horizontal canal, the effect will be that the membranous canal is more or less compressed, the endolymph displaced, and a deviation of the cupula is obtained. The nystagmus then lasts about twenty seconds, as Nylén has already shown. So we have once again the time which the cupula needs to reassume its initial position, by its elasticity.

We can obtain a similar and comparable reaction with caloric stimulation also. If a sufficiently strong caloric stimulus be applied with the head in the optimum position—i.e. with the horizontal canal in a vertical position—the maximal response is obtained after about one minute. If the head be then raised, so that the horizontal canal returns to a horizontal position, the nystagmus continues for a further period of about half a minute, or approximately as long as the nystagmus in the same subject after a rotation test.

What is the reason for this? According to several investigators there should be a fundamental difference between the stimulating mechanism of the rotational reaction and that of the caloric reaction. On the one hand, there is the powerful

but brief nystagmus after a stimulus as that after rotation, which physically appeared to be a strong stimulus. On the other hand, as the result of an apparently weak physical stimulus—the caloric test—a nystagmus occurs lasting as long as two or three minutes. This has given rise to hypotheses attempting to explain the caloric reaction in another way. Bartels, for instance, thought that cooling paralysed the neuro-epithelium of the labyrinth and that warmth stimulated it. Kobrak has tried to explain the caloric reaction as a vascular reflex. By measuring comparatively the threshold for the caloric and the rotatory nystagmus, however, I have previously obtained a physically quantitative agreement between stimulus and effect on the assumption that these two stimuli acted in the same way on the neuro-epithelium. The difference in the physical changes in the canal during rotation and caloric stimulation would then be a question of duration of the physical changes in the labyrinth rather than of difference in the influence on the neuro-epithelium.

After a rotation the cupula suddenly deviates from its normal position and then by its elasticity returns thither. During caloric stimulation, on the other hand, the canal wall cools with gradually increasing alteration in the temperature. In conformity with this, the weight of the endolymph increases during cooling in that part of the horizontal canal that is most lateral and most exposed to temperature change. The change in weight has a tendency to occasion a fluid displacement. But this is first checked by the elasticity of the cupula. No fluid movement can occur because the cupula prevents the endolymph from escaping as it extends across the ampulla. A deviation of the cupula can occur only to the extent that the weight-change in the endolymph balances the elasticity of the cupula. So the mechanism might be comparable to that of a spring-balance, the elasticity of the spring corresponding to that of the cupula, and the endolymph weight-increase corresponding to weights laid successively on the scale. As long as the weights are in the scale the elastic tension of the spring is balanced.

The difference between the two forms of stimulation—rotational and caloric—is therefore, that by rotation we stimulate *both* labyrinths, suddenly; by the caloric test we stimulate *only one* labyrinth, with cumulative force during a relatively long time.

So that if we bring about a deviation of the cupula by altering the endolymph weight by caloric action, and then alter the position of the canal so that it lies horizontally and can therefore no longer affect the cupula, the cupula will be able by its own elasticity to resume its initial position in the same way as during post-rotatory stimulation. The post-rotatory and what I should like to call this post-caloric nystagmus, are presumably comparable, except that the post-rotatory affects both labyrinths and the post-caloric only the stimulated side.

When we investigate the functional capacity of the eye, the sensitiveness of the skin, or the sensitiveness of the cochlea to sound-waves, we do not select the strongest light, the strongest skin-stimulus, or the strongest tone, to see how far perception can continue as we do when using the rotation test. We cause the greatest deviation of the cupula and measure the time till the nystagmus has stopped. The physiologically appropriate way would be to apply the least possible stimulus that can produce a reaction, and from this infer the reactive capacity of the organ. So it ought to be with our current examinations of the labyrinth. Slight and brief turns of the head causing slight and brief deviations of the cupula are the normal, adequate stimuli for the vestibular apparatus. Powerful, long reactions are unphysiological stimulations. They cause dizziness and subjective discomfort which do not accompany the normal function of the organ. Therefore I think we should get more reliable results if we tried to fix the normal stimulability of the organ, and the threshold for its sensitiveness, as far as possible within physiological limits for the strength of the stimulus. Remembering the fact that only speed-alterations during rotation can affect the vestibular apparatus, I think it would be most appropriate to measure

the sensitiveness of the labyrinth by slight increases and decreases during an otherwise constant rotational speed. In that way it would be possible to get the response of slight stimulations and estimate their effect. I have tried to find a method of comparing these accelerations and retardations with the vestibular eye-movements received. Through nystagmographic registrations of the eye-movements and electrical registrations of the speed—and especially of the speed changes of the rotation-chair—I have been able to compare both the response in the form of the vestibular nystagmus and the stimulus-strength, i.e. the increase or decrease in rotational speed (fig. 5).

Now if we examine the caloric stimulations, we find the following: There is the Brüning method of syringing till the nystagmus appears. There is Kobrak's method with small graded quantities of water, where the time of latency and the course of the reaction are estimated. Or there is the method of syringing recently suggested by de Kleijn and Versteegh, in which small quantities of water of varying tempera-

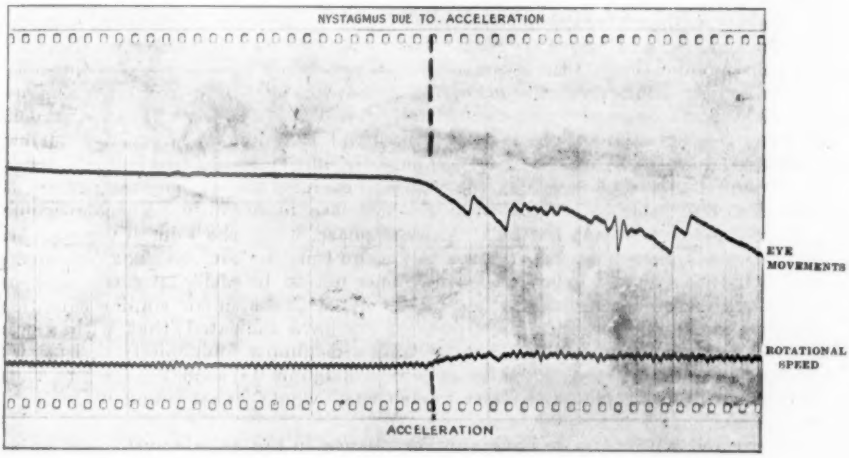


FIG. 5.

ture are employed until just that quantity and temperature that occasion a reaction are obtained. All these methods indicate a degree of heat that is claimed to be a quantitative measure of the stimulability of the labyrinth. But I think this is not the case.

With the caloric reaction we can compare both sides of the same subject. From one-sided deviations we can draw certain conclusions about pathological changes, but we cannot compare the reactions of two subjects, and conclude, from the deviations, anything about the peripheral or central function of the vestibular apparatus. I believe that I can throw some light on this known but less noticed fact, in the following way. Together with one of my assistants, Dr. Kaplan, I have measured the temperature changes of the labyrinth-wall during caloric reaction in radically operated patients with good labyrinthal function, and I found that a raising or lowering of temperature of only from $\frac{1}{10}$ to $\frac{2}{10}$ of a degree centigrade was needed to obtain a nystagmus in one direction or the other. The temperature measured in the operation-cavity was always somewhat lower than the rectal temperature (about 1·5° F.). It is interesting to note that we then actually obtain a

warm-water nystagmus when syringing with water colder than the rectal temperature. But there is certainly not a strongly increased sensitiveness of the labyrinth in these cases even if we get reaction at so slight temperature-changes, rather the contrary. In an ear not operated on, however, we have a barrier of bone and cavities containing air. These take most of the applied warmth or cold, not measurably and regularly, but uncontrollably and irregularly. So that we are primarily measuring the warmth-absorption of the surrounding bone, not the reactive capacity of the labyrinth, or the relation between these values.

In the previously mentioned rotatory stimulus we can, of course, measure the value of the stimulating moment in the peripheral organ through the acceleration and retardation. But the response, the nystagmus, is dependent on two moments, in rotatory as well as in caloric stimulation.

The second moment is the central reaction to the stimulation of the end-organ. Thus the problem is, to what extent the response in the form of vestibulary eye-movements is dependent on central conditions.

We know that a vestibular nystagmus can be altered by fixation, conscious eye-movements, and other cortical and subcortical movements. We have, for example, modifications of the nystagmus after a previous stimulus which have been interpreted as a fatiguing of the centre. A post-rotatory or caloric stimulus does not elicit the same response on repetition. Here I think it necessary to distinguish between the slow phase of the nystagmus and the quick component. I have stimulated human fistulas and experimentally made fistulas in animals, and I have stimulated the labyrinth by the galvanic current, all for lengthy periods, but have not been able to demonstrate any decrease of response. These responses, however, referred only to parts of the slow phase, when the stimuli were so brief that the quick movement of a nystagmus had no time to develop. The consequence of this is that we must suppose the slow phase not to be easily fatigued. Suppose, however, that we study the changes in the quick phase under similar conditions. We find, as Quix, Spiegel and Lorente de Nó have indicated, that with a weak caloric stimulus a nystagmus can be obtained almost indefinitely. But with stronger stimulation the powerful caloric nystagmus is soon changed to slight, quick, oscillatory eye-movements and the whole nystagmus-apparatus is disordered.

Compared with this we have another change in the caloric nystagmus as well as in the nystagmus during and after rotation. After the completed stimulus we have a weak nystagmus in the contrary direction to that previously stimulated. We get this not only with stimulation of the peripheral organ, but also after a galvanic stimulus—which acts centrally beyond the labyrinth—and even after the visual action which produces optokinetic or "railway" nystagmus. All this seems to me to show that the central modification of stimulability during a nystagmus is to be attributed rather to the mechanism that controls the quick phase, than to that which influences the slow phase of the nystagmus.

The rotatory, caloric, and pressure stimuli give a stimulation of the neuro-epithelium in the end-organ. The only one of our investigational methods that acts centrally beyond the labyrinth is the galvanic stimulus. This has not become practically significant, because it gives us no information about the functional state of the peripheral labyrinth, or about the nerve or the central nuclei. If we obtain a galvanic nystagmus at 2, or 4, or 8 ma., we learn nothing of the stimulability of the vestibular apparatus, which in all cases may be equally great, or of that of the peripheral end-organ, as well as the nerve, or the central nuclei. The electrical conductibility of the surrounding tissue may vary so much on account of anatomical differences, in the same way as the warmth-absorbing capacity of the tissue varies in the caloric reaction.

The galvanic current acts centrally beyond the peripheral end-organ. From earlier experiments I thought I might conclude that the current acted in the vestibular ganglion, but from later experiments, and those of others (Huizinga), I think it can be asserted that not even the ganglion is needed for a reaction to occur.

But if we in practical work may abandon the galvanic reaction in its present form as a method of testing the vestibular apparatus, we agree with the change that has occurred in other branches of electro-diagnostics.

Bourgignon, Lapique and others considered that they had found a more correct value for the stimulability of a nerve, theoretically and practically, by introducing as the measure of that stimulability the time during which a certain electric current needs to act for a nerve stimulus to occur. This time-value, which has been called "chronaxis," is usually measured in thousandths of a second.

Practically, chronaxis-measurement is carried out in this way: The lowest current-strength, i.e. one which can just twitch the muscle or stimulate the nerve on test—is tried out. Then the current-strength is doubled and the time of stimulation decreased until the threshold is reached, and this is considered to give the required value for the nerve's stimulability.

Bourgignon has also tried to fix the chronaxis of the vestibular nerve. He has used the vestibular disequilibrium as an indicator of the reaction.

It is plain that the mass and slowness of the body as a whole, and similar irrelevances, must have a most disturbing effect here, and must render the reaction unsuitable as an indicator for a mechanism so subtle and sensitive as the vestibular reflex. The shortest reflex path is between the vestibular apparatus and the eye-muscles. It is also, as is well known, the most sensitive, and the least susceptible of influence by the subject himself.

To be able, however, to use the eye-movements as an indicator in fixing the chronaxis, a nystagmus cannot be utilized. It is the deviation of the eyes which begins the slow phase of a nystagmus that interests us. The quick phase in nystagmus is too irregular in its appearance and has, therefore, no significance in this connexion.

A vestibular eye-movement, though slight, occurs even with very weak stimuli. If a galvanic nystagmus is obtained at from 3 to 4 ma., most frequently even at less than 1 ma., eye-movements can be observed at the switching on-and-off of the current. If the electrically stimulated eye-movements are registered nystagmographically, it is possible to measure the response objectively and to establish its relation to the stimulation-time.

Now, change in current-strength per time-unit forms the strongest stimulus for all other known nerves, and so the faradic current with its continual fluctuations stimulates more readily and during all the time the current is applied, but the galvanic current stimulates only at the points when the current is being switched on or off, or otherwise alters in current density.

With vestibular stimulation, it has generally been considered that things were the other way round. There the galvanic current, the constant current, has been the stimulant, and the faradic current, alternating current, considered incapable of stimulation. But this is not correct. If the chronaxis value of twenty-thousandths of a second found by Bourgignon were correct, it would mean that a stimulus lasting one-fiftieth of a second could give a vestibular effect. If, in other words, the faradic current has a frequency that gives 50 stimulations per second, it can occasion a stimulation-effect. This is so, even with a considerably higher frequency, but the response is not a nystagmus; it is, for every alteration in current-strength, a slight and insignificant eye-movement. These eye-movements are so extremely slight and so frequent that they are not observable by the naked eye, but they can be registered photographically to a frequency of over 150 changes in a second.

We have, however, yet to determine whether this effect on the eye-movements is due to stimulation by changes in the strength of the current at its opening and closing; or to the stimulus usual for the vestibular nerve by the passage of the galvanic current through the nerve, presuming that the current has been passing long enough. The reversal of the eye-movements with the current-direction favours the latter notion.

To solve this problem I made an apparatus with which I could vary the length of the stimulus, and the change in current strength in order to distinguish whether the vestibular nerve reacts only for the passage of the constant current, or also, transiently, as the strength of the current is varied—for instance at the opening and closing of the circuit. Until we know that, we cannot know what phase of the current is the significant stimulus, but I hope that by this method we shall be able to discover these details.

During the era inaugurated by Bárány's important works on the vestibular apparatus we were enabled to arrive at an adequate diagnosis of the diseases of the peripheral labyrinth. Further, intensive work in otoneurology has given us a faithful picture, in many respects, of the central connexions and their function. From this, we have been able to diagnose a number of changes affecting the vestibular nuclei or their connexions. Often, however, our methods are insufficient to decide whether a central or a peripheral lesion is in question. This is apparent from the many suggestions made for the improvement, refinement and alteration of our investigational technique, which indicate that such methods, unfortunately, are not yet altogether satisfactory.

In future, by a more exact interpretation of the results of stimulation of the peripheral organ and by the help in elucidating the function of the central paths, which may be afforded to us by the method of electric stimulation, we shall, I hope, evolve a better technique for the differentiation of peripheral and central lesions of the vestibular apparatus.

I have spoken of rotational, caloric, and electrical stimulation as our methods of practical examination, but that they may not embrace all experimental possibilities has been shown by some work by my collaborator and first assistant, Docent Skoog, who has been investigating the Ménière syndrome, particularly from the point of view of its production by allergens. By injecting into one of the vertebral arteries of a guinea-pig an antigen causing anaphylaxis, he has obtained a group of symptoms similar to Ménière's. For some time after injection the animal develops symptoms of vestibular stimulation in part referable to a disequilibration of the postural reflexes, and in part to changes in the compensatory eye-movements and the functions of the canals. That these symptoms are not referable to the peripheral end-organ can be shown by the fact that the phenomenon occurs unaltered even if a double labyrinthectomy has been performed on the animal.

The phenomenon is plainly bound up with a certain vascular territory. With injection of the same antigen centrifugally into the carotid artery no reaction is obtained. Neither is it obtained by injection intravenously. In these cases, with the same dose only a common anaphylactic shock occurs. The phenomenon may be blocked, by injecting indian ink a short time before the antigen is injected. The reaction corresponds neither to an ischæmia, such as we might expect after an adrenaline injection, nor to decay or damage of the vestibular connexions, as in that case a contrary effect would be expected.

The interesting thing about these experiments is that, with an anaphylactic reaction like those with which we are familiar, in several parts of the body—even in man—we can produce disturbances that are comparable with Ménière's syndrome when the antigen, on certain vascular paths, reaches the vestibular connexions.

Some Further Remarks on Labyrinth Tests

By A. R. TWEEDIE, F.R.C.S.

DR. DOHLMAN has for about fifteen years devoted particular attention to that part of our speciality with which he has just dealt. His researches on the physiology and physics of "caloric nystagmus" were first published in 1925 [1].

This publication, which provides a summary of the work of previous investigators, contained the result of his own research, whereby he was able to establish or confirm amongst other things, that: (1) Compact bone possesses a thermic conductivity six times as great as the air in the middle-ear, and thus that the bony wall and bony external semicircular canal provide the optimum route for the effect of the caloric test. (2) The comparison between the temperature of the irrigating fluid used in this test and that of the semicircular canal, could be easily and accurately gauged. (3) As regards the clinical use of this test, the latent period is almost constant in the same individual, its variation being no more than 4 seconds. (4) The "quick" or "central" phase of vestibular nystagmus is influenced by the optical effect of fixation.

Four years later, another exhaustive article by Dr. Dohlman appeared on the result of his continued investigations towards solving the problem of the labyrinth, and this time, on the galvanic reaction [2]. This is, in my opinion, the best account of this phenomenon yet published.

Once more Dr. Dohlman prefaced his account with an exhaustive survey of the work of previous observers, so comprehensive that, it was doubtless only by inadvertence, mention of Högyes was omitted [3]. In this report Dr. Dohlman described the role which he considered that the vestibular ganglion played in response to the galvanic test, and which, I believe, had previously never been suggested. His valuable and well-reasoned conclusions on this point were summarized in the statement that: The galvanic reaction depended in no way on the condition of the terminal sensory organ but on the functional integrity of the vestibular ganglion. I am sorry that he now feels obliged to modify this view, which seemed to me very helpful in the explanation of some of the responses obtained; though I must admit that I have had a case of severe herpes in which the auditory sense and caloric reactions were both totally lost on one side, whilst a normal galvanic response was retained; and, in this case of course one would be justified in assuming that there was some lesion of the vestibular ganglion. In addition, Dr. Dohlman also quoted some instances in which the caloric reaction had been obtained with no response to the galvanic stimulus; and offered, as the solution for this puzzle, the presence of an intracranial lesion.

Not content with all this effort, Dr. Dohlman published yet another paper (with Dr. Engvall) in 1930 [4], on the time-reaction in response to the caloric and galvanic tests, from which he deduced that the resulting nystagmus with the galvanic stimulus was at least twice as prompt as that obtained by the caloric test.

This sketchy résumé of Dr. Dohlman's contribution towards the solution of our problems, neither includes all his writings nor does adequate justice to those quoted, which must have represented many patient years of work; while his own hypercritical deductions will always be of inestimable value to all concerned in otology.

In submitting any of my own views on the subject, I have little further to offer since the last occasion on which I placed them before the Section [5].

I then suggested amongst other things that in vestibular nystagmus we are dealing with very simple physiological phenomena, similar to the tickling reflex, and I have since been gratified to find that no less an observer than Lorente de Nó had just committed himself to much the same statement in a paper which I had not

then seen [6]. I also said, "We know more of the physiological results of artificial stimuli than of the effects of pathological lesions"—a statement which I find is also confirmed by Lorente de Nó in a letter received from him this February, in which he writes: "The individual variations are so enormous that it is very difficult to state when a response begins to be pathological"—but I am glad that he was able to qualify this remark by a further statement that he was beginning "to find constancy in the results" to his tests; and, that in a still later letter he could write yet more hopefully as to the result of his employment of the caloric test, based on the use of varying temperatures of water applied for various lengths of time, which latter factor, he says, is all-important and assessed by counting the number of nystagmic movements thus obtained.

We are still, however, faced by the lack of an accepted standard of comparison as between individuals, in whatever way we arbitrarily employ the factors of time, volume and temperature as a gauge in the caloric test, and adopt a margin of 1 to 5 ma. for the average amount to induce the head inclination, and 5 to 10 ma. for the production of nystagmus for the galvanic test, as suggested by Baldenweck and Barré [7].

Although, however, we have this absence of accepted standard *as between individuals*, I would point out that we have in most cases a standard *for each individual*—that is to say, in most cases, there is one sound, or comparatively sound, side with which to compare the ear in question—a method which indeed is not altogether without analogy in testing reflexes in other parts of the body.

This introduces the question of asymmetry between the two sides, to which I have before alluded [8], which Dr. Dohlman has also stressed, and which I too maintain that we are justified in utilizing fully in estimating the labyrinth condition for each patient; since I think I may state that it exists, as regards one or more of the tests, in every case of vertigo which I have examined. I was interested, in this connexion, to read that such asymmetry had also been found by de Kleyn and Versteegh in the examination of most of the 100 cases of which they recently published an account [9], cases not associated with any inflammatory lesion and constituting a class in which I consider these tests to be most valuable. That their tests were carried out with that meticulous aim at accuracy with which we have all learnt to associate the names of these observers, needs no emphasis from me, but they were restricted, one must note, to the effect of the caloric and rotation stimuli alone. It would have been of extreme interest to know the response of these patients to the galvanic test in comparison with and in addition to the results obtained from the other methods as summarized by the authors with such great care; but de Kleyn, to whom I wrote on the subject, replied that they had not used the galvanic tests, as they found it more difficult to estimate the slight differences of irritability between the two sides—a reply at which I must confess I was rather surprised, since, of all the three tests, I have found the galvanic test to be the most adjustable, as it can be confined to the effect on one side. Also, since its application can be "continuous," it is the most easy, for me at any rate, to assess as to response; and, further, it certainly acts independently of the peripheral sensory organ. On the other hand, the rotation test must always involve some bi-lateral simultaneous stimulation—a point which Dr. Dohlman has also emphasized.

Incidentally in this paper also, as might be expected, these authors have dealt with the entry of otolithic action into such cases and they were able to separate their patients into four groups:—

(1) Those in whom the vertigo was not related to any definite position of the head in space.

(2) Those in whom the vertigo and nystagmus were dependent on a definite position of the head in space.

(3) Those in whom the vertigo and nystagmus were dependent on a definite position of the head in relation to the body.

(4) Those in whom there was no sensation of rotation either in the patients themselves or in their environment, but to whom the environment seemed to be set obliquely.

This is a very valuable classification and the whole contribution will certainly rank as an important standard reference on the subject.

Although as I say, I have found the vestibular tests most useful in non-inflammatory cases, there is yet a further group where I think they may be of use, that is those subacute inflammatory conditions in which it is difficult sometimes to decide between palliative and operative treatment. This idea was suggested by Mr. Lieberman, one of the clinical assistants in the Aural Department of the Nottingham General Hospital, who is now carrying out investigations on these lines, under the ægis of the "Norman Gamble Fund" Committee. His results appear to offer some help and will be published later.

No account of the present position in labyrinthology would be complete, as Dr. Dohlman has ably indicated, without reference to the work of Steinhausen on the living pike—work that opens up vistas of promise, which as Dr. Dohlman's paper has shown, is no mere fanciful speculation, and serves as development of the early work of Flourens and Ewald, whose shades must certainly be haunting Greifswald [10].

I would only venture to draw attention, in addition to the remarks of Dr. Dohlman, to the fact that Steinhausen also considers the rotation tests as unreliable, because the stimulus employed could not be restricted to the effect on one side, and his investigations are based on the action of mechanical and galvanic stimulation. From these experiments of his, three important points emerge: (1) That the ampullo-petal movement of the endolymph causes first a displacement of the cupula and then a deviation of the eyes to the opposite side, and (but *not unless* the stimulus is maintained) a secondary "nystagmus" to the same side; whilst an ampullo-fugal movement, although displacing the cupula, results in no eye-movement; (2) that the galvanic current causes no movement of the cupula, but (3) that a galvanic current of not more than 0·6 ma., directed from the utricle, through the ampulla to the canal, induces a deviation of the eyes to the opposite side, whilst even a current of 4 ma. in the reverse direction has no effect.

These results, at any rate, tend to confirm the importance of the primary deviation and also seem to indicate that in the galvanic test it is indeed the kathodal ear alone which is activated.

We are greatly indebted to Dr. Gösta Dohlman for the description of this work by Steinhausen and for his own investigations.

These brief remarks are intended to represent, at once, a sincere tribute to the past work of others, an indication of the present position of our knowledge, and a stimulus to further endeavour in solving the problem of the labyrinth.

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Discussion.—The PRESIDENT, on behalf of himself and of the Section, thanked Dr. Dohlman for having come to this meeting to give a wonderful example of the modern phase of physiological surgery. He thought the importance of the labyrinth did not receive its due recognition in general medicine; for instance, the importance of toxic conditions affecting the vestibular centres, and also in everyday phenomena, such as fainting, in which the labyrinth was involved. There were three main types of mechanism in the labyrinth: the saccule and the utricle in the central division, the cochlea in the anterior section, and in the posterior division and the semicircular canals.

Dr. Dohlman had explained the crista mechanism. He (the President) wondered whether Dr. Dohlman suggested an explanation of the mechanisms by which the cochlear and macular stimuli operated.

Sir JAMES DUNDAS-GRANT said he had listened to these two communications with great interest. The counsels of perfection which Dr. Dohlman had offered ought to stimulate otologists to greater accuracy, but while these new methods were being perfected he hoped those working in the specialty might still use their simpler methods. He (the speaker) was himself responsible for having invented a cold-air apparatus, the adoption of which had considerably increased, though, after hearing such a paper as that read to-day, one felt it must be regarded as a convenient rough-and-ready method. It enabled one to obtain a very fair estimate of the degree of sensitiveness of the vestibule. The galvanic method was simple and effective, and it certainly gave a great deal of information. One placed the anode on the ear to be tested, and the kathode on the back of the neck or other indifferent spot. The patient stood with toes and heels together, and then the current was turned on until there was a postural deviation towards the anode which was unmistakable but did not cause the patient inconvenience. He had had several cases of cerebellar-pontine angle tumour in which the loss of reaction revealed by simple galvanic testing was of the greatest confirmatory value.

[The paper on "**The Treatment of Otosclerotic and Similar Types of Deafness by Local Application of Thyroxine,**" read at this Meeting by Dr. ALBERT A. GRAY, will be published in the next issue of the *Proceedings* of the Section.]

Section of Obstetrics and Gynæcology

President—EARDLEY HOLLAND, F.R.C.S.

[*May* 17, 1935]

DISCUSSION ON DIET IN PREGNANCY

Dame Louise McIlroy: In opening a discussion on diet in pregnancy one has to be wary in expressing definite opinions on the relative values of food-stuffs, as so little is known of the physiological changes which take place in normal pregnancy. We know that the diet must be mixed, ample but not excessive, in order to meet the demands of the metabolic and tissue changes resulting from the grafting of the ovum upon the maternal organism. The importance of diet and nutrition is being recognized in the study of diseases generally and an increasing number of affections can now be classified as deficiency disease.

Take, for example, pulmonary tuberculosis. This is doubtless due directly to the tubercle bacillus, but by means of good food and fresh air and sunlight, we are able to prevent and treat the disease. Perhaps in time by similar methods we shall prevent puerperal sepsis as we are now preventing toxæmia to some extent.

Many of the manifestations of pregnancy toxæmia owe their origin to deficiencies in the mother, of various substances required for her own health and for the nutrition and growth of the fœtus.

Mellanby has stated that nutrition is the most important factor in childbearing and is closely related to maternal and infant welfare. Munro Kerr says there would be few cases of toxæmia if women partook of ordinary simple diet, and drank four pints of fluid daily. Orr and MacLeod find that in farm animals susceptibility to disease depends on the quality and quantity of food. It is well known that disease almost always follows famine.

The object of antenatal care is to maintain the health of the mother and to prevent the onset of those metabolic disturbances of pregnancy which are of greater danger than malpresentations and deformities of the pelvis. Many of the complications of labour are due to malnutrition of the uterus, a condition which we are still pleased to call inertia.

Infant mortality has been reduced in the present century to almost half its previous extent, but there has been no reduction in the first four weeks of life. The cause of premature births and marasmic infants is to be found in malnutrition and toxic conditions of the mother. Deficiencies in diet are predisposing factors in the causation of hæmorrhages and infections and are factors contributory to a high maternal mortality.

It is mainly in the larder and kitchen that we will find the solution of the problem of prevention, rather than in the pharmacy or chemical laboratory.

Maternal and fœtal storage of nutritional substances is a most interesting line of research. The fœtus requires food-stuffs for nutrition and growth. It also has its reserves in case of failure in the maternal supplies. In pregnancy, the liver is the chief detoxicating organ and it is concerned with storage. The placenta is the purveyor or distributor and the storehouse for the fœtus; it also acts as a filter. Defective placental function means fœtal starvation. If the reserve supplies become depleted the maternal tissues must yield their vital substances for the use of the fœtus, as the latter is imperious in its demands and, as a rule, the mother comes off worse. By starvation in pregnancy we mean either failure in intake, or defective assimilation of some particular substances necessary to maintain the physiological balance of pregnancy. Among these may be mentioned vitamins and calcium. In the persistent vomiting of pregnancy—which is labelled toxæmia—if death occurs, the post-mortem findings are similar to those of starvation, proving that this persistent vomiting is a manifestation of diet deficiency.

The chief substances required for the maintenance of life are water, carbohydrates, proteins, fats, vitamins, and mineral salts.

Pregnant women, as a rule, do not drink sufficient water. They should have 3 or 4 pints daily alone and in tea, soups, &c. Why do we order boiled water? Fresh water contains more mineral salts, and promotes peristalsis and diuresis.

Milk contains all the elements sufficient for maintaining life. It is especially useful in pregnancy because of its protein, fat, and calcium content. Why should there be such an outcry against the sterilization of milk by which it is rendered free from the germs of such diseases as scarlet fever which indirectly causes kidney damage, toxæmia and, thus, maternal mortality? Why is there so little talk of the damaging effect of cooking and preservation of vegetables and other food-stuffs?

Vitamins can be added to supply the deficiency in milk. After all, raw milk is deficient in vitamins unless it is absolutely fresh. Dried milks are deficient, if not entirely wanting, in vitamins, and also in fats to a great extent. A pint of milk should be taken daily throughout pregnancy. It seems a pity that Public Health authorities will only supply milk to expectant mothers during the last few months of pregnancy. Milk, cream, and butter if supplied from grass-fed animals are much more valuable than if obtained from those kept in stalls away from the light.

Carbohydrates are changed into sugar, and the liver is the chief storehouse of glycogen. It is essential for nutrition, for the neutralization of fatty acids, and for the maintenance of the normal alkalinity of the blood. The liver is especially sensitive to toxins in pregnancy and it can only resist these or change them into harmless substances if the supply of glycogen is maintained. Proteins and fats are called upon if carbohydrates are deficient. The present fashion of "slimming" with its low carbohydrate intake and high protein and fat diet may have repercussions on the future mothers of the race. The chief carbohydrate supplies are bread, cereals, vegetables, sugar and sweets, honey, jam, &c.

Proteins: Nitrogen is required throughout pregnancy for nutrition but especially during the fifth and sixth months, when fœtal growth is at its highest and there is a greater drain upon nitrogen reserves. Nitrogen is required for the increase in the bulk of the uterus, for the formation of the placenta, for the loss by hæmorrhage at parturition and for lactation. If there is proteinuria, the drain is greater and this must be made up in the diet. Protein is supplied in meat, eggs, milk, fish, chicken, peas and beans and vegetables. Meat should not be taken in the latter half of pregnancy because of its harmful toxic substances. Among better-class patients excessive protein intake it more common, owing to expensive and attractive foods. There is as much danger of overeating in pregnancy as in deficiency of diet. The popular idea that the mother must eat for two is a dangerous fallacy. Daily open-air exercise is the best antidote to excess in protein intake.

Fats: Fats are required for the production of heat and energy. In the last

few weeks of pregnancy fat is drawn from the maternal intestine to supply the subcutaneous fat in the fœtus. Premature infants are thus deficient in fat as a rule. Acidosis may be the result of the imperfect oxidation of fats.

Vitamins: It is not necessary here to give a detailed description of the various vitamins. An excellent and comprehensive review on the subject is given in the *Medical Research Council Special Report*, 1927, No. 117. This report states that very little investigation into diets in pregnancy has been carried out. The vitamins A and D, which are fat-soluble, are of special interest in pregnancy. A is concerned with growth and the prevention of infection. It is supplied in carotene, vegetables, fruits, and marmite. D is the antirachitic vitamin and is closely associated with calcium and sunlight and thus prevents rickets, caries of the teeth, and osteomalacia. It is present in fresh milk, butter and cream, fresh green vegetables and fruit. The substitute for vitamins A and D is cod-liver oil, a necessary but expensive substitute for a mixed diet. There is some danger in giving excess amounts of irradiated food-stuffs. One effect of these is to cause overgrowth of the fœtus.

Vitamins are markedly deficient in the diet of women attending hospital clinics especially in industrial areas. These women live on bread because it is bulky and inexpensive. They buy tinned and preserved foods because they save trouble in preparation and cooking. Unfortunately fresh vegetables are expensive and rapidly lose their vitamin content on storage and if cooked slowly. With rapid cooking at a high temperature there is less vitamin loss. Soda in the water destroys the vitamin content of the vegetables.

Mineral salts: Calcium is of great interest, as we have learned from clinical observation as well as from laboratory experiments. Phosphorus is important in respect of its ratio to calcium. Calcium with vitamins A and D is concerned with liver-detoxicating function and with bone and tissue-formation in the fœtus. The greatest demand for calcium is in later pregnancy when bone-formation is greatest. Maternal depletion is shown in caries of the teeth, muscular cramps, insomnia and excessive fœtal movements. The relationship of calcium deficiency to toxæmia and osteomalacia is now well known. The average newborn infant contains 30 grm. of calcium and 19 grm. of phosphorus. This shows the enormous drain upon the mother in pregnancy. The mother requires calcium for lactation. The average diet is poor in calcium. A pint of milk contains 1·3 grm. Calcium is also contained in cereals and vegetables.

Iron is stored in both the maternal and the fœtal liver. The liver of the newborn has more iron than that of an adult. It also contains a little copper. The fœtus draws its supply from the maternal hæmoglobin in the red blood-corpuscles and the nucleo-proteins. It is said to draw some from the destructive action of the trophoblast on the maternal blood-vessels. When the maternal tissues are depleted of iron, anæmia is the result—a result frequently observed in women attending ante-natal clinics. The fœtus requires iron for its blood and tissues. It also stores iron in late pregnancy for the period of lactation when iron in milk is deficient. This storage is in excess of the maternal retention. Helen MacKay has pointed out that anæmia in infants is to some extent due to deficiency of iron in the mother. The storage is incomplete in premature infants who often require to be treated with iron.

Iron is supplied in a mixed diet, green vegetables, spinach, watercress, eggs, meat, calf's liver. Why prescribe expensive extracts when fresh cow's liver is of more value than cod-liver oil? I have controlled cases of morning sickness by giving iron.

Iodine is associated with endocrine function, but we know little of its effects. It is supplied in sea-fish, such as herrings, which live on algæ. Iodized table-salt is given frequently in pregnancy.

Sodium chloride seems to be a necessary ingredient in diet, in spite of much controversy on the subject. Harding and van Wyck point out its dangers in toxic

conditions and they have found that increase in weight or occult œdema is a manifestation of salt-excess and tissue-thirst in the maternal organism, sodium being looked upon as the harmful factor. Routine weight-taking in an antenatal clinic gives a valuable indication of the nutrition of the mother. If deficient in weight, she is under-nourished. If weight is excessive, fats and carbohydrates should be cut down and salt should be excluded from the diet for a few weeks. If the weight rises suddenly there is danger of impending kidney damage or toxæmia. It is an earlier sign than raised blood-pressure or albuminuria, and is evidence of fluid retention in the tissues.

In conclusion: Attention to diet is of the utmost importance in pregnancy, and a suitable mixed diet of fresh foods is the surest method of preventing toxæmia and other deficiency complications. Professor E. Mellanby makes the following suggestion for a diet in pregnancy. Milk 1-2 pints; green vegetables once or twice daily; one or two eggs daily; sea-fish (for iodine content) twice weekly or more frequently. Calf's liver can be given once a week; the rest of the diet is to be within reason as the patient wishes. If deficient it should be supplemented with cod-liver oil ℥ii daily.

Women should be taught how to purchase and cook food in order to obtain the best possible value from it for the supply of their own wants and that of the fœtus. Less attention should be given to expensive artificial food preparations which are often poor substitutes for an ordinary mixed diet. Advice as to the cultivation of vegetables—based on scientific knowledge of pregnancy requirements—should not be beyond the notice of the obstetrician.

Dr. G. W. Theobald: *The dietetic deficiency hypothesis of the toxæmias of pregnancy.*—The purpose of this communication is to state, explain, and offer evidence—both clinical and experimental—in support of my hypothesis of the toxæmias of pregnancy. No reference will be made to others, except in so far as may be necessary for the purpose defined. This hypothesis is that "all the ailments and toxæmias associated with pregnancy are caused by an absolute or relative insufficiency of some substance or substances in the diet, the most important of which is calcium, which leads to an inharmonious working of the various physiological processes in the body and ultimately to hepatic dysfunction" (1933).

Tweedy (1911) believed—

> "That food is the actual exciting cause of eclampsia, and the primary cause of the toxæmia giving rise to heart failure."

He suggested that the

> "Concentration of the toxins which arise from maternal and fœtal waste may overtax the excretory organs and cause degeneration" . . . affecting the epithelium of the intestinal tract and allowing food particles . . . "to enter the circulation ununited with, or incapable of uniting with, their proper antibodies."

The hypothesis under consideration differs as widely from Tweedy's as it does from any other. Its implications are: (1) That the toxæmias of pregnancy can be prevented; (2) that there is no essential difference in the mode of causation of any of the toxæmias; (3) that renal symptoms are merely incidental and that the kidneys play no part in the causation of the toxæmias: (4) that there is no such thing as a pregnancy toxin.

With regard to the last implication: Firstly, eclampsia and most severer forms of the pregnancy toxæmias have an undoubted geographical incidence. This can only be explained on the assumption that these diseases are to some extent dependent on the environment, of which, apart from infection, diet and sunshine are the most

important factors. Secondly, even in eclampsia, more than 60% of the infants are born alive. It follows that the toxin is not diffusible. It is certainly unusual that a toxin capable of causing such widespread lesions in the maternal organs should leave the infant undamaged. Moreover, no significant lesions are found in the organs of the majority of the stillborn infants of eclamptic mothers. Thirdly, the toxæmic manifestations of pregnancy are extremely varied and differ widely, so that no system of the body escapes. There is no analogy for the assumption that these widely differing manifestations could be caused by one toxin – a dozen would hardly suffice. Fourthly, while it is true that extensive destruction of the liver, kidneys and other organs may be associated with eclampsia, it is also true that significant histological lesions may be absent from the organs of women dying from eclampsia. Hence gross structural damage is incidentally but not causally associated with eclampsia. Fifthly, many observers have injected blood withdrawn from eclamptic patients intravenously into animals without causing toxic symptoms. Høst (1931), indeed, transfused 750 c.c. of blood withdrawn from a patient immediately after an eclamptic fit into a patient suffering from carcinoma ventriculi without affecting the blood-pressure or causing any untoward symptom. This evidence, in conjunction with the fact that workers in every civilized country have for many years sought it in vain, almost amounts to proof of the non-existence of a pregnancy toxin.

If this be true it is necessary to explain how the symptoms and serious histological lesions which may be associated with eclampsia can be caused, and why such a syndrome is peculiar to pregnancy.

I have reported elsewhere (1930) that serious hepatic lesions, including hæmorrhages in the periphery of the lobules, may be caused in dogs by feeding them on a cooked lean meat diet. These lesions occurred more rapidly and were more severe if the animal receiving the diet was pregnant. These experiments were not devised to investigate what deficiency or deficiencies were responsible for the hepatic or other lesions in the animals but to demonstrate the fact, hitherto unreported, that hepatic lesions may be produced in dogs by feeding them on a high animal protein diet deficient in several factors. I further reported (1932 (*a*)) that very severe, and in some cases fatal hepatic lesions, together with small hæmorrhages in the brain were caused in cats and dogs by frequently raising the intra-abdominal pressure to above 80 cm. of water for two minutes. Here again the most severe lesions occurred in a pregnant cat. [Evidence was also offered (1932 (*b*)) to suggest that the general intra-abdominal pressure is not significantly raised during pregnancy in animals or in man.] Strauss and Maddock (1934) were unable to confirm the fact that raising the intra-abdominal pressure in the manner described causes histological changes in the dog's liver. These workers used animals which had been kept for some time on a well-balanced diet (Strauss, private communication 1935) whereas those I used, both in Bangkok and in London, had been kept on a very badly balanced and definitely incomplete diet. Seeing that histological changes (which could not be attributed to chloroform, since they occurred in the liver of a dog narcotized with morphine) were indubitably caused in the animals I used, and were verified by two independent and eminent histologists, it can only be assumed that the state of nutrition of the liver cell largely determines its resistance to the effects of anoxæmia. The fact that lesions occurred in dogs on an incomplete diet and not in those on an adequate diet, that similar lesions could be caused by feeding animals on a high animal protein and inadequate diet, and that in both cases the histological changes occurred more rapidly in pregnant animals, makes such an assumption reasonable. Its proof will depend on direct experiments which it is proposed shall be undertaken. The lesions found in the liver and other organs of women dying from eclampsia, which would appear to be the strongest evidence of the existence of a pregnancy toxin, may therefore reasonably be ascribed to mechanical and dietetic factors.

This assertion cannot be justified unless an adequate reason be furnished as to

why eclampsia should be peculiar to pregnancy. Known deficiency diseases are numerous, and range from scurvy, beri-beri, lathyrism, and pellagra to the nutritional anæmias and keratomalacia, but these occur in men, women, and children, although osteomalacia in its most severe form is peculiarly associated with pregnancy. The fundamental difference between the pregnant and the non-pregnant state is that the fœtus robs the mother of important substances which she may not be able to afford. The fœtus, a true parasite, makes its demands without any regard for the mother, and she meets these demands. In osteomalacia the maternal blood-serum calcium may be half its normal value, while that of the fœtus is normal. The mother may be profoundly anæmic, while the fœtal blood-count exceeds 6,000,000 per cubic millimetre—and so it is with all the essential substances. (*Vide* Sachs, Levine and Fabian, 1935.)

It is commonly assumed that the merest trace of each of the vitamins in the diet is sufficient for the individual. Evidence is accumulating to prove that definite amounts of each vitamin, and in the case of vitamin B considerable amounts are necessary to the well-being of the individual. Some persons require more of a given vitamin than others, their tissues being less economic in its usage. Further, food itself requires vitamins in order that it may be satisfactorily assimilated, and a high animal protein diet requires more vitamins B and D than a mainly carbohydrate diet. This is why a meat-free diet has proved beneficial in the treatment of the toxæmias of pregnancy. Famine sufferers betray many symptoms, including œdema and ascites; a starving man merely suffers from inanition. Serious deficiency of one vitamin may interfere with the actions of others, and there can be no reasonable doubt that the harmful effects of vitamin deficiency are enhanced if the diet be unbalanced. I have pointed out (1930, 1933) that the polyneuritic type of beri-beri has a higher incidence in pregnant than in non-pregnant women or in men, and have suggested that the polyneuritis of pregnancy which occurs in this country is a manifestation of beri-beri. Pregnancy undoubtedly requires an increased intake of all the vitamins, and if the woman commences gestation with a low vitamin reserve and if the intake is insufficient she suffers, and the possibly ensuing symptoms are manifold.

I believe that the toxæmic symptoms of pregnancy are precipitated by inadequate available supplies of iron, iodine, and calcium, and possibly of other inorganic substances. Pregnancy obviously demands an increased intake of iron and it is true that but few hospital patients have anything approaching a normal blood-count. Although anæmia—even profound anæmia—may not be associated with toxæmic symptoms, most seriously toxæmic patients are anæmic, and this is particularly true of patients suffering from chronic nephritis with toxæmic symptoms. It is surely reasonable to assume that an anæmic woman is less capable of adjusting her calcium metabolism to the increased requirements of the fœtus than one whose blood-count is normal.

It is moreover established that an increased intake of iodine is necessary during pregnancy. Seeing that the thyroid regulates the body metabolism, influences the other endocrine organs and has a direct effect on renal secretion, and that most inhabitants of this island who live away from the sea are on the verge of iodine deficiency, it can be safely postulated that pregnant women are liable to suffer from the symptoms which arise from temporary thyroid deficiency.

It has, however, been asserted that a disturbance of the calcium metabolism is the most important factor in the causation of the toxæmias of pregnancy (Theobald 1930, 1933). Seeing that the woman always has about 2 kg. of calcium in her skeleton she does not suffer from lack of calcium in the body, but from insufficiency of calcium in a suitable form in her blood-stream. Here I would stress the point that estimations of the total blood-serum calcium are almost worthless. The calcium metabolism is governed by the parathyroids, vitamin D and, possibly, by

vitamin B. Tetany is not always associated with a low blood-serum calcium, and even osteomalacia may occur in the absence of this symptom. It could not be expected that this latter disease, associated with a prolonged and comparatively rapid drain of calcium from the bones to the excretory organs would be associated with the toxæmias of pregnancy or eclampsia, and on the authority of Maxwell and Green-Armytage (1934) it is not. In the pregnancy toxæmias the body is incapable of mobilizing the calcium locked up in the bones with sufficient rapidity, and from this point of view the conditions are in pronounced opposition. Further, osteomalacia during pregnancy is not associated either with an extension of dental caries or with falling out of the hair (Maxwell, 1934, personal communication) two conditions which can be prevented by calcium therapy. Moreover there can be little doubt that the calcium-phosphorus ratio—and perhaps merely the amount of phosphorus in the blood—are of greater significance in the causation of osteomalacia than mere disturbance of the calcium metabolism. There is no evidence that the amount of phosphorus in the blood is of any marked significance in the causation of the pregnancy toxæmias. The calcium ions subserve a large number of functions in the body and the number of symptoms which may be associated with calcium deficiency is only limited by the number of these functions. The fundamental differences between calcium deficiency occurring during pregnancy and that occurring otherwise are: (1) The suddenness of the disturbance of a satisfactorily functioning metabolism; (2) the fact that in the presence of a deficiency, relatively large amounts are continually being abstracted from the maternal circulation. The proof that disturbance of the calcium metabolism may result in manifold toxæmic manifestations during pregnancy is furnished by the fact that they are cleared up by the administration of calcium.

My hypothesis would best be proved if it could be shown that a large group of women put on an adequate diet early in pregnancy did not develop toxæmic symptoms at any time during their pregnancies. Such an experiment offers very considerable practical—as well as technical—difficulties, for food provided for mothers tends to find its way into the children's mouths, nevertheless I hope that it may be organized.

If the hypothesis is true it does not follow that the symptoms could be quickly cleared up by an adequate diet. Anæmia due to deficient iron intake takes time to respond to treatment, while beri-beri and other known deficiency diseases often require months of treatment before cure is effected. If, however, it can be shown that a reasonable percentage of patients suffering from the toxæmias of pregnancy can be cured merely by adding substances to their diet, it is surely proof that the symptoms were caused by deficiency of those substances in the diet. This is the evidence I propose to offer.

During the last sixteen months 68 toxæmic patients were admitted to the antenatal ward of St. Mary Abbots Hospital, during which time between 1,200 and 1,300 patients were confined. I have not included in this number patients suffering from hyperemesis gravidarum, morbus cordis, debility, varicose veins, and other medical conditions, nor those admitted for hypertension whose blood-pressure came down to the normal within forty-eight hours. The hyperemesis gravidarum patients were not included because, although they all responded rapidly to treatment, other lines of treatment have proved successful elsewhere, so that their inclusion does not help the argument. Until the first of January of this year the patients were under my control, and from that date the unit has formed part of the post-graduate medical school under the direction of Professor James Young. I take this opportunity of thanking him sincerely for his sympathetic interest and for permitting me to continue my research.

Each patient, on admission, was put on the diet described below and was allowed to get up and amuse herself in the afternoons and evenings. Violent

purgation was not resorted to, neither were the patients made to drink large quantities of fluid. The urine was in every case cultured and examined for casts, and the amounts passed by day and by night were charted separately; if albumin was present it was estimated and recorded daily (Esbach's albuminometer). A blood-count was made on all patients who appeared anæmic, and commencing towards the end of last year the Wassermann reaction was determined for each patient. The diet was as follows:—

ST. MARY ABBOTS HOSPITAL

Ward 5. Diet Sheet.

Bacon	...	2 oz. daily	Butter	...	1½ oz. daily
Liver	...	6 oz. (3 times a week)	Cheese	...	1 oz. daily
Meat	...	3½ oz. (3 times a week)	Biscuits	...	2 oz. daily
Eggs	...	3 daily	Sugar	...	2½ oz. daily
Fish	...	8 oz (once weekly)	Oranges		
Milk	...	2 pints daily	Greens and other vegetables daily		

Patients with hypertension received fish daily. They were allowed bacon but not liver or meat until the blood-pressure returned to the normal.

ST. MARY ABBOTS HOSPITAL

Ward 5 "Routine."

Calcium gluconate	...	...	...	10 c.c. (intramuscularly, weekly)
Calcium lactate	...	...	...	gr. 5 b.d.s.
Advita[1] capsules	...	...	...	6 daily
Thyroid extract (siccum)		...	...	gr. 2 daily
Bemax[2]	...	...	...	2 oz. daily
Iron (mist. ferri. et ammon. cit.)			...	gr. 20 t.d.s.
Sulphur	...	...	...	gr. 5 b.d.s.

In severe cases the injections of calcium are given on alternate days and the number of advita capsules is increased to 20 daily.

[1] A preparation containing vitamins A and D.
[2] ,, ,, vitamin B.

Albumin was found in the urine in clinical amounts in 18 patients who attended the ante-natal clinic. Twelve of these were in the ante-natal ward for three days or longer; in the case of eight the albumin disappeared from the urine before delivery. Five had a trace of albumin in the urine when discharged. Four had a normal blood-pressure during the whole of their stay in hospital. Two patients gave birth to twins, and all went out with living children, save one who was in the ante-natal ward for only eight days. This patient, who did not have more than 0·18% albumin in the urine which cleared rapidly, should, according to the rules, have been admitted to the ward six weeks earlier when her blood-pressure exceeded 140 mm. Hg.

In the same period 15 patients with albuminuria whose previous ante-natal history was unknown were admitted from outside sources, of whom 12 spent four days or longer in the ante-natal ward. The albumin disappeared from the urine of three of these before delivery and from a further four before discharge. The others left with a trace or faint trace of albumin. The uterus was emptied at about the twenty-eighth week of pregnancy in two patients suffering from chronic nephritis. Three infants were premature and stillborn; two were macerated, and one died on the third day after delivery. In only three cases was the blood-pressure normal, and in five it exceeded 170 mm. Hg. Eight of these patients complained of headache associated in the case of three with vomiting, while six showed marked œdema, in two cases involving the abdominal wall, and in one of them the vulva, as well.

Twenty-six patients were admitted because of hypertension, the great majority from the ante-natal clinic. Eight patients showed œdema, 10 complained of

headaches and two of vomiting. All except one gave birth to living children and one patient gave birth to twins. One infant died from cranial hæmorrhage following forceps delivery, and one died showing a congenitally malformed heart and transposition of the viscera. No post-mortem examination of the third infant was made. A trace of albumin was present in the urine of eight of these patients and in every case cleared up within a few days and before delivery. One patient was only in for one day before delivery, and in 11 of the remaining 25 the blood-pressure became normal before delivery. Six patients left hospital with a blood-pressure definitely above the normal, the highest being $\frac{150}{90}$-$\frac{160}{100}$ mm. Hg.

Nine patients were admitted mainly because of œdema. Three of these complained of headaches and two of vomiting; one complaining of headaches, vomiting and eye symptoms. Three patients had a trace of albumin in the urine which cleared up before delivery, but the blood-pressure was normal in each case. Four patients were primigravidæ of whom two had had scarlet fever and diphtheria, and one had had scarlet fever and "abscess of the throat." One multigravida had had diphtheria. One infant was stillborn, probably because the cord was twice tightly round the neck. It is nevertheless of interest to note that although the mother in this case had a normal blood-pressure and never passed albumin in the urine, yet her blood-urea was 42 mgm.% and 55 mgm.% on the two occasions on which it was estimated.

The following are brief histories of two patients each demonstrating points worthy of emphasis:—

I.—L. D., a 2-gravida, aged 22, whose previous ante-natal history was unknown, was admitted with a blood-pressure of 205/130 mm.Hg and her urine loaded with albumin. She complained of severe headaches, disturbance of vision, and abdominal pain. Her abdomen was so tender that the medical officer was unable to determine the lie of the child. He

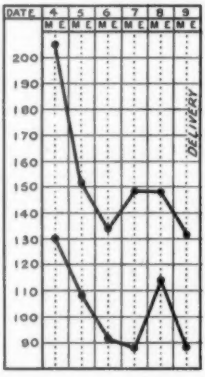

FIG. 1.—Blood-pressure chart, the upper curve representing the systolic and the lower the diastolic pressures recorded daily and expressed in millimetres of mercury. (*See* text.)

noted "threatened eclampsia for immediate induction." She suffered from headaches towards the end of her first pregnancy which resulted in a stillborn fœtus. All her symptoms cleared up within forty-eight hours, the blood-pressure fell rapidly (fig. 1), the urine four days later only contained 0·025% of albumin and she gave birth, six days after her admission, to a living child.

II.—A. D., a 3-gravida, aged 33, was admitted because of hypertension. The systolic blood-pressure except for occasional intermissions, which are a feature of such cases, was maintained at a level of about 160 mm.Hg for three and a half weeks, the diastolic varying between 90 and 100 mm.Hg. After this period the blood-pressure fell and was at the level

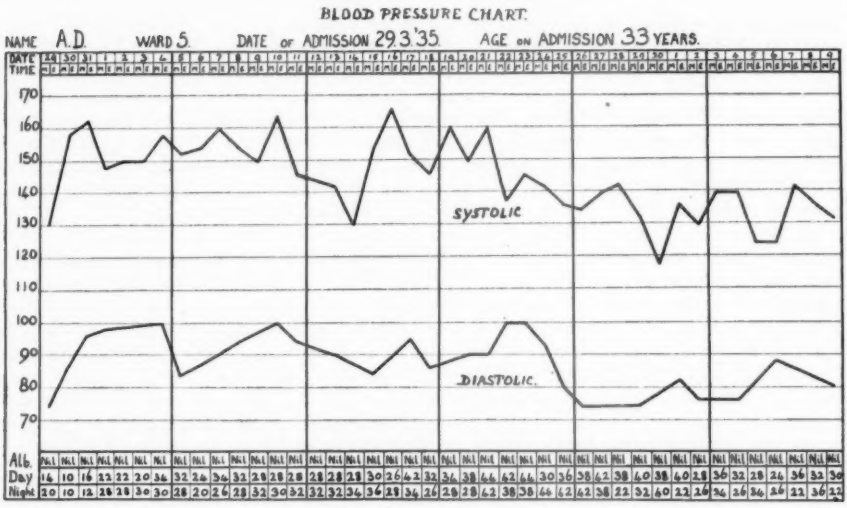

FIG. 2.—Blood-pressure chart, the upper curve representing the systolic and the lower the diastolic pressures recorded daily and expressed in millimetres of mercury. The figures in the lower two columns represent the amounts of urine passed by day and by night and expressed in ounces. The chart ends when delivery occurred. (*See* text.)

of 130/80 mm.Hg when delivery occurred six weeks after her admission to hospital. It is clear that the blood-pressure did not fall in this case because of rest in hospital (the patients are not confined to bed) and it is reasonable to assume that it took three and a half weeks for the adequate diet to correct the errors in metabolism arising from dietetic deficiencies and resulting in hypertension.

If it be contended that similar results may on occasion be obtained merely by confining the patients to bed on a light or starvation diet, it supports the hypothesis, for rest in bed slows down the maternal metabolism and allows the necessary adjustments to be made. It has already been postulated that animal protein in the diet requires an increased intake of calcium and vitamins B and D, and this explains the good results obtained by cutting meat out of the diet and also the decreased incidence of eclampsia in Germany during the latter period of the war. The invariable and rapid disappearance of such symptoms as headache, vomiting, disturbance of vision, and œdema, as the direct result of adding substances to the diet and without resort to violent purgation, are inexplicable unless interpreted in the light of the hypothesis on which the treatment was based.

Sixty-eight toxæmic patients were therefore admitted during the period under review, of whom 39 were primigravidæ. Of these patients, 25 complained of headaches, 6 of eye symptoms, 9 of vomiting, while 27 had œdema. The uterus was emptied on only two occasions, at about the twenty-eighth week of pregnancy, both patients being sent in from outside and suffering from chronic nephritis. One of these patients suffered in addition from pyloric obstruction and a profound anæmia, necessitating two blood transfusions. Six infants were stillborn and three died during the first week of neonatal life. Of the stillborn infants one was born the day the mother was admitted from an outside source with 2·4% of albumin in the urine, and one was born with the cord twice round the neck. It is of interest that the symptoms of the mothers who bore the remaining four stillborn infants had cleared up rapidly on admission, and before they went into labour, although the interval between admission and delivery was less than a fortnight, except in the

case of one woman, in whose case it was fifteen days. The chart of one such patient is shown (fig. 3).

She was aged 44, 5-gravida, was admitted to hospital with extreme œdema of both legs and over the anterior abdominal wall, headache and shortness of breath. Her systolic blood-pressure was 210 mm.Hg, the diastolic being 110 mm.Hg, while her urine was loaded with albumin. The œdema and other symptoms cleared up within forty-eight hours; the blood-pressure came down to 124/82 mm.Hg in four days and the urine became albumin-free before delivery. The fact that her infant was stillborn (death occurring not more than two days before delivery) merely shows that the substances in which her diet had been deficient were supplied too late.

I reported in 1930 that if pregnant bitches were put on a cooked lean meat diet the fœtus invariably died and became absorbed. I have since found that if pregnant bitches be fed on a similar diet and calcium be added the fœtus survive. Recent work on vitamin E has confirmed the view that dietetic factors are of the utmost importance in preventing the death of the fœtus *in utero*. Stillborn infants offer no argument in favour of a pregnancy toxin, for it has been shown that a high percentage of eclamptic patients give birth to living children, rather do they support the view that the toxæmias of pregnancy are the result of food deficiencies.

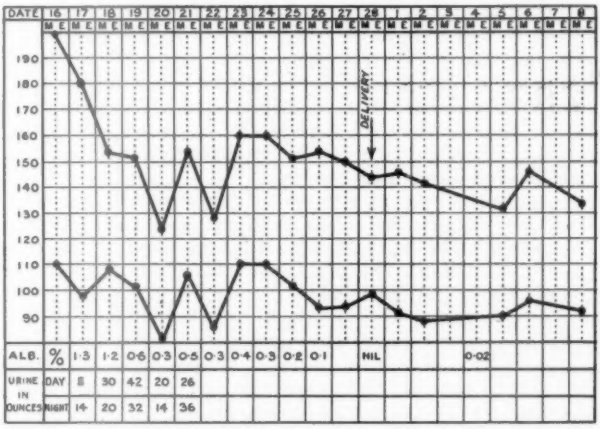

FIG. 3.—Blood-pressure chart, the upper curve representing the systolic and the lower the diastolic pressures recorded daily and expressed in millimetres of mercury. (*See* text.)

The pyelitis of pregnancy.—I have not included in this series those patients who suffered from the pyelitis of pregnancy. All of them responded to alkaline treatment when placed on the routine diet, the urines of two severe cases becoming sterile before delivery. One patient who suffered from severe attacks of pain simulating renal colic showed very marked dilatation of the ureter, pelvis, and calices of the right kidney. The urine contained no pus and remained sterile.

Mere mechanical factors predispose to, but do not cause, pyelitis, and I am convinced that actual infection of the urinary tract depends to no little degree on the state of nutrition of the body in general and of the cells of the urinary tract in particular.

Albumin during the puerperium.—I have frequently found that patients whose urine contained no albumin up to, and after delivery, passed considerable amounts of protein in the urine during the early days of the puerperium. Moreover, in quite a number of cases the blood-pressure of patients suffering from hypertension reached

its highest level some four to six days after delivery. Both these facts are inexplicable on any other hypothesis than the one under consideration. The special diet stopped when the patients went up to the labour ward.

Morbidity.—It is generally assumed that toxæmic patients are more likely than ordinary patients to become morbid. Of the 68 patients delivered only two were morbid as judged by the B.M.A. standard, and in one case the pyrexia was due to an abscess caused by the injection of calcium gluconate. The other morbid patient was the case of chronic nephritis, anæmia and pyloric obstruction whose uterus was emptied. Of the other patients only six ever exceeded a temperature of 98·4° F. during the first eight days of their puerperium; the vast majority never on a single occasion recording a temperature of 98·4° F.

I have reported elsewhere (1933) that caries of the teeth, falling out of the hair, and brittle finger-nails can be prevented, and that cramps, morning sickness, hyperemesis gravidarum, pregnancy urticaria, dermatitis herpetiformis and excessive salivation can be cured, by calcium-therapy. I have shown that headaches, vomiting, œdema, and eye symptoms occurring late in pregnancy can be rapidly cured by placing the patients on the diet mentioned. The results cannot be attributed merely to rest in bed, for the patients were not confined to their beds. On the other hand more than one patient before admission had been confined to bed without any improvement. The albumin cleared up before delivery in 8 of the 18 ante-natal patients admitted to the ante-natal ward because of albuminuria. If the small amounts of albumin present in the urine of patients admitted because of œdema and hypertension be included, then it cleared up before delivery in 19 out of 29 patients. I hope, on another occasion, to deal more fully with albuminuria, but here I would say that in the vast majority of cases protein in the urine is not associated with any structural changes in the kidney, and indeed may arise apart from even functional changes in that organ.

Seven patients left the hospital with blood-pressures definitely above the normal but there is reason to believe that their pressures were raised before they became pregnant. One patient, for example, a primigravida aged 26, was admitted with a blood-pressure of 200/130mm. Hg which came down to 155/120 mm.Hg in three days. She was discharged with a blood-pressure of 150/100 mm.Hg, but her brachial and radial arteries were markedly thickened, and the physicians had diagnosed her to be a case of essential hypertension.

Pregnancy and chronic nephritis.—It is widely held that the toxæmias of pregnancy are liable to cause chronic nephritis—a view which I consider erroneous for three main reasons: (1) No control investigations have been made on adequate groups of single women: (2) the patients suffering from the toxæmias of pregnancy have been incompletely investigated; (3) writers on this subject betray a lack of acquaintance with the elementary laws of statistics. I propose to deal with this question more fully elsewhere, but would here make the following observations.

(1) Hypertension is more common in young single women than is generally realized. (2) It has been assumed too readily that because a patient had no albumin in the urine when she first attended an ante-natal clinic that she did not have nephritis. I will give two examples from a number whose records I have. One patient has a blood-pressure of 118/78 mm. Hg, the urine contains no albumin and yet the blood-urea has varied between 47 and 59 mgm.%. The other has never had either albumin or casts in her morning urine which has been examined on many occasions, nevertheless her blood contains 63 mgm. % of urea and 66·8 mgm.% of non-protein nitrogen. (3) I have shown, I believe conclusively that, so far as England and Wales are concerned there is no significant causal association between pregnancy and nephritis (1933(*b*)). It is beside the point for observers to state that they have watched chronic nephritis progressing in their patients over a period of years. What they must prove is: (1) That the patients did not have nephritis before they

became pregnant for the first time ; (2) that chronic nephritis would not have occurred even if they had not become pregnant.

If my view is correct it follows that nephritis is a common cause of signs and symptoms attributed to pregnancy toxæmias and that the obstetrician has the opportunity of adding to our knowledge of the early stages of chronic nephritis, for he sees the patient ten years before she would normally consult the physician because of symptoms. It is also my belief that chronic nephritis is a misnomer, for I believe

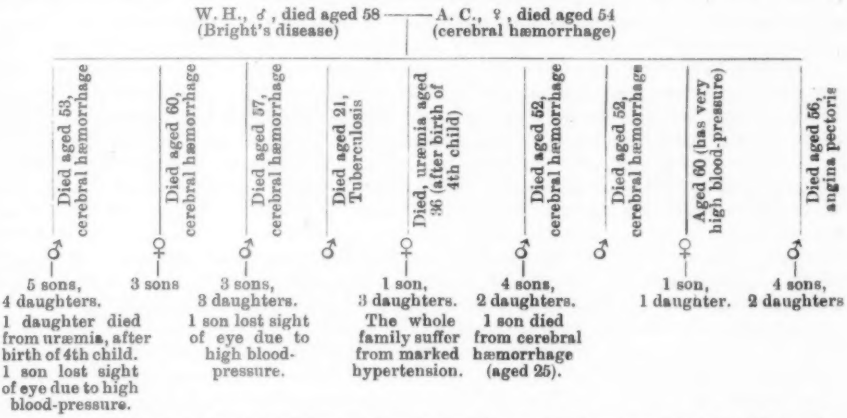
W. H., ♂, died aged 58 (Bright's disease)
A. C., ♀, died aged 54 (cerebral hæmorrhage)
Died aged 53, cerebral hæmorrhage
Died aged 60, cerebral hæmorrhage
Died aged 57, cerebral hæmorrhage
Died aged 21, Tuberculosis
Died, uræmia aged 36 (after birth of 4th child)
Died aged 52, cerebral hæmorrhage
Died aged 52, cerebral hæmorrhage
Aged 60 (has very high blood-pressure)
Died aged 56, angina pectoris
5 sons, 4 daughters. 1 daughter died from uræmia, after birth of 4th child. 1 son lost sight of eye due to high blood-pressure.
3 sons
3 sons, 3 daughters. 1 son lost sight of eye due to high blood-pressure.
1 son, 3 daughters. The whole family suffer from marked hypertension.
4 sons, 2 daughters. 1 son died from cerebral hæmorrhage (aged 25).
1 son, 1 daughter.
4 sons, 2 daughters

FIG. 4.—Table showing the hereditary nature of some forms of "chronic nephritis." Of the nine children of two parents who died, the one from Bright's disease and the other from cerebral hæmorrhage, six died from either cerebral hæmorrhage or uræmia, while the one surviving has a very high blood-pressure. Of the grandchildren, one has died from uræmia and one from cerebral hæmorrhage, two have lost the sight of an eye through hypertension, while one whole family suffers from marked hypertension. It is of interest to note that one daughter and one granddaughter died from uræmia, death occurring in both cases after the birth of the fourth child.

that a considerable proportion of all cases arise as the result of an inborn error of metabolism; and that the progress of the condition depends to no small degree on dietetic factors. It is difficult to explain the undoubted fact that heredity is an important factor in the incidence of chronic nephritis on any other assumption (*vide* fig. 4).

Nephrectomy during pregnancy.—In the last three years I have had four patients under my care who have been delivered subsequent to nephrectomy. In the case of three the operation was performed between the third and fifth months of pregnancy, twice because of early tuberculosis and once because of Dietl's crisis. In these three cases the kidneys when removed were functioning normally. Notwithstanding the fact that all the work was suddenly thrown on to one kidney when pregnancy was well advanced, none of these patients had more than the faintest trace of albumin in the urine at any time during their pregnancies which were in all respects normal. Such terms as "low reserve kidney" have no physiological or clinical significance and there is no evidence that pregnancy throws any very great load on the kidneys. In my judgment many of the symptoms attributed to "kidneys" are an expression of a metabolic upset and have no more relation to renal damage than diabetes has to the kidneys. Whether or not a woman with definite chronic nephritis can go through pregnancy without further damaging her kidneys depends as a rule more on her general health and blood-count than on any ascertainable kidney damage.

I therefore submit that the dietetic hypothesis can explain every known fact concerning the toxæmias of pregnancy and relates them all one to the other, those

during the early months being more due to qualitative and those during the latter months to quantitative deficiencies. The results of the treatment of patients in whom symptoms have arisen amount almost to proof of the hypothesis, for it has been pointed out that the hypothesis would not have been invalidated if the dietetic treatment of the patients had proved a complete failure. All the symptoms were invariably cured and with rapidity, and only albuminuria and hypertension resisted treatment in a proportion of cases. Seeing that pregnancy is associated with considerable mechanical disadvantages and that these two states had become well established before treatment was instituted, the surprising thing is that so many patients became normal before delivery occurred.

If this hypothesis be true it follows that diet is of supreme importance during the period of lactation. This is not the occasion on which to discuss this question, but the "feeling that strength has gone out never to return" can be prevented by assuring the lactating woman an adequate diet with plenty of calcium and vitamin D.

I believe, moreover, that patients before operation benefit enormously by being put on the "routine" described. Further, if such symptoms as headache, disturbance of vision, dermatitis, herpetiformis and other rashes, hypertension, albuminuria, jaundice, vomiting and polyneuritis are due to dietetic deficiencies during pregnancy it is obvious that the same symptoms occurring in the non-pregnant state may be due in part, or in whole, to the same factors. Thus a new and wide field of promising study into the early stages of many diseases is opened up.

Furthermore, if this hypothesis be correct, it is illogical to retain the term "toxæmias of pregnancy." I suggest that all deficiency diseases such as beri-beri, pellagra and osteomalacia be called the "atēlosītēses."[1] The nutritional anæmias would then be termed the "atelositetic" anæmias, while the pregnancy toxæmias would be called the "encymonic atelositeses."

In conclusion, the main conception underlying this hypothesis is not to present a new treatment for the toxæmias of pregnancy, but to assert that they may be prevented, and that a healthy pregnancy and lactation are impossible apart from an adequate diet on which also depends to a large extent the health, present and remote, of the fœtus. "La vie libre" depends on "la fixité du milieu intérieur" and "la fixité" or the resistance to significant changes, which are so liable to occur during the adjustments demanded by the pregnant state, can only be assured if an adequate diet be provided. It is clear that changes in the "milieu intérieur" are more likely to occur on the first occasion that these adjustments are attempted than during subsequent pregnancies. I feel emboldened to claim that this Section should appoint representatives to study the results of the treatment of toxæmic patients on the lines I have described and to organize experiments to discover whether the toxæmias of pregnancy can be prevented. If the hypothesis be correct it should be relatively simple to save some four to five hundred lives annually in England and Wales alone.

It is my privilege to thank Sir Frederick Menzies, the Chief Medical Officer of the London County Council, for permission to publish data concerning patients at St. Mary Abbots Hospital. I have, moreover, much pleasure in expressing my sincere thanks to the Medical Superintendent, Mr. J. Carver, for his interest and coöperation, and to the nursing staff, and in particular, Miss Baker, the Sister-in-charge of the ante-natal ward, without whose help these results could not have been obtained.

Summary.

The toxæmias of pregnancy have an undoubted geographical distribution and must therefore depend on environment, of which, infection being excluded, diet and sunshine are the most important factors.

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The state of nutrition of the liver cells determines their susceptibility to anoxæmia.

Sixty-eight toxæmic patients in the latter months of their pregnancies were treated in a period of sixteen months; of these, 44 had albuminuria, 52 had hypertension, 27 showed œdema; 25 complained of headaches, 6 of eye symptoms and 9 of vomiting. The only treatment was the addition of substances to the diet.

The symptoms of all except one cleared up completely. The albuminuria and hypertension proved resistant to treatment in just over half the cases.

The uterus was emptied twice in cases of chronic nephritis.

Six infants were stillborn.

The pyelitis of pregnancy cannot be attributed solely to mechanical factors.

Albuminuria frequently occurs during the puerperium in women known to have passed urine free from protein, both during and after delivery, while the blood-pressure in toxæmic cases may reach its highest level some four to six days after the birth of the child.

There is no evidence that chronic nephritis is causally associated with pregnancy, although unsuspected nephritis may give rise to symptoms suggestive of pregnancy toxæmias.

Four cases confined after nephrectomy are reported.

If such symptoms as headache, dermatitis, and other rashes, hypertension, albuminuria, jaundice, vomiting and polyneuritis are due to dietetic deficiencies during pregnancy, it is probable that the same symptoms occurring in the non-pregnant state may be due in part or in whole to the same factors.

All the toxæmias of pregnancy can be prevented by an adequate diet.

It is claimed that the results reported have no interpretation other than in the truth of the hypothesis on which the treatment was based.

It is suggested that the word "atelositeses" be used to denote deficiency diseases. The pregnancy toxæmias would thus be called the "encymonic atelositeses."

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well be favoured by similar dietetic faults. Frank tetany during pregnancy, perhaps most commonly met with in association with osteomalacia, is similarly to be regarded as due to the state of negative calcium balance. It is now believed in many quarters that the painful aches and cramps which occur during pregnancy have a similar origin, and it has been claimed that they yield readily to the supply of extra calcium and vitamin D.

Disturbances in the calcium metabolism may have important effects other than those already mentioned. In support of the thesis of Dr. Theobald are observations made by Mendenhall and Drake (1934) on the effect of supplementing the diet of pregnant women with calcium salts and vitamin D. Among 188 women treated in this way two developed some form of toxæmia, while among 230 control women observed during the same period 30 developed toxæmia.

There is considerable evidence derived from animal experiments to show that those factors in the diet and environment during pregnancy which favour calcium assimilation have a definite effect in aiding the normal calcification of the offspring after birth. It is true that the effect is small when compared with the effect of the diet of the offspring themselves after birth, but it is none the less present. In order, therefore, to ensure the best possible development of the child's skeleton, the calcifying properties of the mother's diet during pregnancy should be adequately ensured. It is rare for infants to be born showing manifest disturbances of their calcium metabolism, but such cases have been described in association with osteomalacia in the mother. The existence of even rare examples of fœtal rickets indicates the probability that lesser degrees of disturbance in the calcium metabolism during pregnancy may predispose infants to the development of rickets after birth.

The simplest method of ensuring an adequate supply of calcium and phosphorus during pregnancy is to consume comparatively large amounts of milk. The work of Toverud and Toverud (1931) indicated that from 1·6 to 2·0 grm. of calcium a day were usually required to prevent calcium loss in pregnant women. One quart of milk contains about 1·5 grm. of calcium, and the consumption of liberal quantities of fresh vegetables, in addition to this amount of milk, should furnish an adequate calcium intake. It is of course possible to add calcium to the diet in the form of soluble salts, but it would seem preferable to add it in a natural form such as milk, which contains numerous other valuable food factors which are required in a special degree during pregnancy. Extra vitamin D cannot always be ensured in climates such as ours by exposure to sunshine, and few natural foods contain it in any abundance. Yolk of egg is comparatively rich in this vitamin and good dairy produce should contain moderate amounts. A very good case can be made out, however, for the separate addition of some richer source of this vitamin during pregnancy. This source may be cod-liver oil or a concentrate prepared either from fish-liver oil or irradiated ergosterol.

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Dr. H. N. Green : Much of the experimental work bearing on the problem of the relation of nutrition to infection has been recently reviewed by Clausen [1]. A considerable number of investigations, both in the laboratory and the clinic, have been carried out, but we cannot yet assign with any certainty the exact role of diet in the prevention or treatment of infection. Diet is one factor undoubtedly, but how small or how large a factor remains to be elucidated.

As a broad generalization there is little doubt that a "poor" diet may produce a lowering of resistance—and probably to a less extent, an increased susceptibility—to infection. Clinical investigations, such as those of Clausen [2] and Spence [3], have emphasized this fact in regard to young children. In the case of vitamin A

deficiency, it is well established, experimentally, that in certain species of animals, a greatly increased liability to spontaneous infection occurs. It has yet to be shown conclusively, however, that in this deficiency state there is any marked fall of resistance to an artifically inoculated infection. What does appear definite (at least in the case of vitamin A) is that increasing the intake beyond the amount necessary for optimal nutrition does not produce an increased resistance to infection [4]. The vitamin, at least in the rat, has no specific drug-like effect.

It was this great tendency to spontaneous infection in the vitamin-A-deficient rat and the rapid utilization of this vitamin by growing tissues that led Professor Mellanby and myself to investigate its use in the prophylaxis and therapy of puerperal sepsis. I have shown that, in the rat, the demands for vitamin A increase during pregnancy and that a relative deficiency in this vitamin renders the reproductive tract after gestation more liable to develop sepsis of a chronic type, a type, however, not strictly comparable with the acute sepsis of the puerperal woman [5].

Estimations of the vitamin-A reserves of the liver in women dying after childbirth have been made. Previous results [6] chiefly dealt with women who had received vitamin-A concentrates after the septic state had commenced. The inability of the liver to store much of the ingested vitamin during severe puerperal infection was revealed. Further results in women who were not given vitamin preparations have shown that the vitamin-A content of the liver is much lower on the average than in the normal adult and that the number of cases showing subnormal reserves is much greater than in most other diseases. A brief summary of the results is set out below. The findings of Moore [7] in 61 cases (aged 15 years upwards) of accidental death or acute poisoning occurring in Britain are included as a basis of normality. The number of females in this series is small but the results, as well as those from a much larger series of pathological cases, definitely show that the range of reserve in the female is certainly not lower but probably higher than in the male. Both the average and median figures for the different groups are given. The median is the most representative figure, owing to the wide variations in values which are found in both normal and pathological livers.

Type of Case	No. of cases	Vitamin A Blue units per grm. liver		No. of cases with reserves below 50 units per grm. liver
		Average	Median	
Normal (accidental death) 40 males, 8 females	48	425	300	6 (13%)
Normal (females only) (accidental death or acute poisoning)	13	460	337	2 (15%)
Puerperal septicæmia ...	32	124	66	14 (2 devoid of vitamin A)
Puerperal sepsis. Blood cultures negative. Chiefly cases of peritonitis	17	272	78	5
All septic cases	49	175	66	19 (39%)
Puerperal deaths from causes other than sepsis	13	224	133	5 (38%) (3 devoid of vitamin A)

It would seem quite definite from these results that the vitamin A reserve of the woman after pregnancy is often much less than that in the normal adult. Moreover the septic cases tended to show lower reserves than the non-septic cases but the exact significance of this is not clear, for obviously in most of the non-septic cases the patients died at a much earlier stage of the puerperium. Some of the non-septic group may have been potentially septic cases. For instance in the three non-septic cases (two of eclampsia and one of heart failure), in which there were no vitamin-A reserves, the patients died before any gross signs of sepsis could have developed. If these are excluded from the group the average value rises from 224 to 292 and the median from 133 to 212 units.

It is, of course, very difficult to decide whether the low vitamin-A reserves found in many cases were a predisposing cause or merely an effect of the disease, or even represent a physiological state in the puerperium. There is a little experimental evidence in favour of any of these views [8, 9]. The liver analyses revealed that in some cases high vitamin reserves (of the 49 septic cases six gave values above 350 units, the highest being 1,214) co-existed with severe infection, and it is well recognized now that ample reserves are no guarantee against infection. Nevertheless, until more is known, it would appear rational, on the basis of these results, which indicate possibly low reserves (i.e. an arbitrary value of below 50 units per grm. of liver) in 40% of women dying in the puerperium, to ensure a good supply of vitamin-A-containing foods during pregnancy, and to give moderate doses of cod- or mammalian-liver oil, when such foods are not available with any certainty.

Experimental progress is being made with methods for the determination of the vitamin-A and carotene content of the blood, and it may soon be possible to detect those women who have subnormal reserves. If such is the case, prophylactic experiments with vitamin A could be devised on a more scientific basis, for the experimental evidence indicates that it is only those women with a deficiency in their vitamin reserves, who could be expected to benefit by such treatment.

It is important to realize that low vitamin-A reserves are very probably associated with low reserves of other nutritional factors. A low intake of vitamin A might easily be associated with a low intake of vitamins C and D, of iodine, and of such minerals as calcium, iron and manganese. The liver results may actually be an expression of some unrecognized—and possibly more important—deficiency in regard to resistance, than vitamin A.

The results obtained by Professor Mellanby and myself [10] in a prophylactic experiment in which an extra supply of vitamins A and D was given during the last month of pregnancy, again suggest that this dietary supplement has to some extent diminished the incidence and severity of sepsis in the puerperium. Therefore, with regard to prophylaxis, it may be concluded that the total evidence indicates that optimal supplies of vitamin A during pregnancy should diminish the liability to a morbid puerperium. It appears to me that the final assessment of the prophylactic value of substances rich in vitamin A could well be made in a country such as India where the hospital classes almost certainly contain a much larger proportion of individuals with very low reserves of this vitamin than is the case in Britain.

Our results in the treatment of puerperal sepsis [11] are more difficult to interpret chiefly because they have not been confirmed by other workers. A mortality of five in a series of 18 cases of hæmolytic streptococcal septicæmia appeared to be a striking improvement on the previous mortality rate at the same hospital. The difference between this result and that obtained in the Glasgow investigation [12] may possibly have been due to the improved general diet in our cases, for where possible, the diet included much milk, green vegetables, eggs, in addition to the vitamin-A concentrate. It is at present, however, impossible to be dogmatic regarding the value of this treatment, particularly as Colebrook has reported in one isolated series of 15 cases of puerperal septicæmia a recovery rate of 73%, in the absence of any specific treatment [13]. One factor in this treatment, which may be of importance, is the possible toxic effect of liver-oil concentrates in large doses. There is some experimental evidence [14] that this toxic factor may be neutralized by large amounts of the vitamin-B complex and now that concentrated preparations of the B vitamins are becoming available, use might be made of these in any further tests as to the therapeutic value of liver-oils in puerperal septicæmia.

That other nutritional factors may be concerned in maintaining the resistance of the pregnant woman is almost certain, but there is, as yet, little experimental

evidence available. Helen Mackay's work on anæmia and the incidence of infection in young children [15] naturally suggests that the prevalence of hypochromic anæmia in pregnant women may have an important bearing on their susceptibility to infection. A negative calcium balance, another common feature of the pregnant state, may be another factor. Also it should not be forgotten that, as shown by Sure [16], the demands for the vitamin-B complex of the lactating rat are at least three times those of the non-pregnant rat.

Another important contribution to the future prophylaxis of puerperal sepsis should be the complete eradication of rickets. The major deformities of rickets are now disappearing, but minor degrees are still common and it seems plausible that these may affect the bony pelvis to such a degree as to produce later a traumatic, rather than a normal, labour.

Insidious disturbances due to badly balanced diets are likely to become more pronounced when the extra demands of pregnancy occur. We know little as yet, but enough to be certain that dietary faults exist, leading to a lowered resistance. Future progress will be great if the subject can be investigated on larger animals, with longer gestation periods than those of the small laboratory animals. The effects on resistance of partial and combined vitamin deficiencies, of lipoid and mineral deficiencies, of changes in the acid-base value of the diet, and of complete, but badly-balanced, diets, are a few of the problems awaiting investigation.

I am indebted to Dr. L. Colebrook who forwarded most of the liver samples used in this investigation, and to Dr. Moore for allowing me to abstract data from unpublished results.

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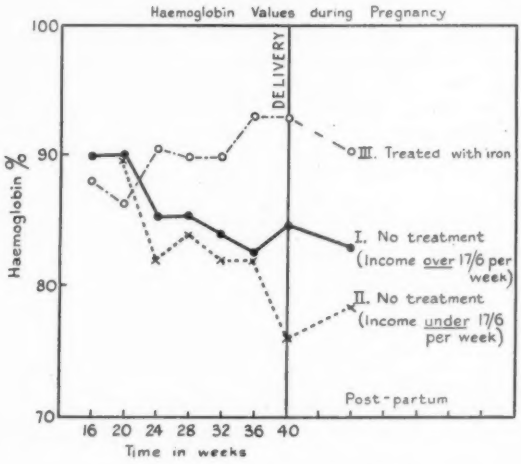
Dr. Lucy Wills: It seems to me a fundamental error to consider pregnancy as an abnormal condition requiring special treatment, such as diet. The diet of a healthy young woman should be adequate to support the additional demands made at this time, if the dictates of increased appetite are duly regarded. Unfortunately the diets of the majority of people are either quantitatively or qualitatively deficient and women are therefore unable to stand the extra strain put on the organism by pregnancy. It is generally necessary therefore to supplement the diet of expectant mothers in order to safeguard them from deficiency diseases. Two nutritional anæmias constitute serious problems—an iron-deficiency anæmia and an anæmia secondary to a deficiency in the pernicious anæmia factor, so-called nutritional macrocytic anæmia or tropical macrocytic anæmia. The former is a world-wide problem: the latter is only of importance in certain countries, for example, India, parts of China and Central and West Africa.

The hæmopoietic deficiency-anæmia due to a lack of iron is a hypochromic anæmia, which results from either an insufficient iron intake or a faulty absorption of this element. A great deal of work has been done recently which demonstrates that this anæmia is extremely common in all parts of the world, especially in women

and infants. In all countries the condition appears to be conditioned by a supply of iron in the diet that is inadequate to meet any extra drain on the iron supplies of the body, such as, for example, the drain of pregnancy, or the continuous slight blood loss associated with hookworm disease. In Scotland, Davidson and others (1) have shown in a group of the industrial population that the iron in the diet (average 0·0107 grm. daily per man value) though adequate to maintain the blood levels in men and children, is not sufficient to meet the extra demands of repeated pregnancies and excessive blood-loss, so that a low grade hypochromic anæmia is extremely common among the women. In other words the female population of such industrial areas, as a class, begin pregnancy with insufficient iron reserves, and cannot make up this deficiency on their iron-poor diet, so become progressively more anæmic throughout pregnancy. Dealing with rather better-off patients, my colleagues, Dr. Pillman-Williams and Miss Moore have obtained somewhat similar results which they have allowed me to use. The accompanying chart shows hæmoglobin values obtained from a series of healthy pregnant women attending the ante-natal



clinic at the Royal Free Hospital. The women are grouped according to family incomes, those with incomes of 17s. 6d. or over per week (excluding rents) and those with incomes below this figure. Curves 1 and 2 give the average hæmoglobin values for these two groups throughout pregnancy and one week after delivery. Both curves fall, but that of the second group much more markedly. The third curve is that from a similar group of women treated throughout pregnancy with large doses of iron (iron ammonium citrate grains 90 daily). In this group the hæmoglobin values rise to a normal figure of 90% and remain at or above this throughout pregnancy. This brings us at once to the question of the so-called physiological anæmia of pregnancy.

It is commonly taught that there is such an anæmia which is partly due to an hydræmia and partly to the extra demands on the organism made by the fœtus. If this is so, is there being induced a pathological plethora in the patients treated with iron, or is the so-called physiological anæmia of pregnancy only an expression of an unrecognized slight iron deficiency? The latter explanation seems worthy of consideration, as the patients treated with iron are remarkably well and free from symptoms. Before leaving the question of this iron-deficiency anæmia, it is necessary to refer to the work of Strauss and Castle [2]. These workers consider

that in some cases the anæmia is conditioned by a faulty absorption of iron, due to a failure in gastric secretion, rather than to a direct iron deficiency. Undoubtedly in many women, as pregnancy progresses, there is a decrease in gastric acidity which runs parallel with the drop in hæmoglobin, but there is no conclusive evidence that the anæmia is directly due to faulty absorption of iron. It may well be that the gastric failure is also due to a relative deficiency in the diet, possibly of the vitamin-B complex, a deficiency which is known to cause a failure in gastric secretion. It seems more likely that the anæmia is due primarily to a deficient intake of iron, and is perhaps rendered more severe by faulty absorption. Experiments on really well-fed women, not of the hospital class, would be of great interest in connexion with this question of diminished gastric secretion.

If this hypochromic anæmia of pregnancy is a simple iron deficiency, its prevention should depend on making available to all classes an iron-rich diet. Such a diet must be taken before, as well as during, pregnancy, so that the iron reserves of the body may be maximal before pregnancy begins. It should include an abundance of meat—especially kidney and liver—eggs, spinach, lettuce, bananas, prunes, whole grain—especially oatmeal—and chocolate and cocoa. Cruz [3], in S. America, has shown that the population of the ranching parts of the country, whose wages generally include a ration of meat, though heavily infected with hook-worm, do not suffer from anæmia, which decimates the population of the non-stock raising districts, which is no more heavily infected, but has a diet very poor in iron-containing foods. An iron-rich diet should therefore be the key to the cure and prevention of this anæmia, but till economic conditions put such a diet within the reach of the bulk of the population, iron, in large doses, should be prescribed as a routine throughout pregnancy.

The second nutritional anæmia occurring in pregnancy is the macrocytic anæmia, previously described as pernicious anæmia of pregnancy, but now recognized as being a particular example of the nutritional macrocytic anæmia which affects men and women in certain countries, and is only rendered more severe by the extra demands made on the organism during pregnancy.

It was my lot to work on this disease in India for several years. It was soon obvious that the condition was not limited to pregnant women, and had all the characteristics of a deficiency disease, such as scurvy or osteomalacia. A dietetic survey undertaken in the city of Bombay showed that the entire hospital population existed on diets that were incredibly deficient in every way—in quantity, proteins, fats, vitamins, and salts. A similar anæmia could, however, be produced in monkeys fed on a diet based on one in common use among sufferers from this disease, and the condition prevented by the addition to the diet of autolysed yeast (marmite). Further, the condition was curable in man by the addition to the diet of either some liver preparations or of marmite. Though similar to idiopathic pernicious anæmia, which may be a rare complication of pregnancy, it was distinct from this condition (presence of free acid in gastric juice of majority of cases, normal van den Bergh reactions, absence of nerve symptoms, &c.), and all the evidence suggested that it was a straightforward food-deficiency disease, the deficiency being in the extrinsic factor described by Castle as necessary for the formation of the anti-pernicious-anæmia factor stored in the liver. This extrinsic factor is present in meat and marmite and probably in many other food substances, but its exact nature has not been determined. My own work in Bombay, and further experiments done here in London with monkeys, indicate that it is not vitamin B_2, though closely associated with this vitamin, but the recent work on the inactivization of part of this vitamin by light, makes further work along these lines necessary.

The world-distribution of this anæmia shows that it only occurs in areas where the diets are of a poverty and uniformity never seen in the British Isles even in extreme poverty. When the exact nature and distribution of this missing factor

is known, it will probably be possible to enumerate numerous food-stuffs that will prevent or cure the condition. At present in those areas where the condition is endemic the authorities should aim at increasing the consumption of meat or, in vegetarian countries, should encourage the use of some autolysed yeast product. All pregnant women should be put on a diet including liver in some form, or marmite, either of which, in small amounts, would probably be effective prophylactically. When the condition has developed, especially in severe cases near term, treatment is urgent, and the best is intramuscular injections of some liver extract, such as campolon, but in the majority of cases large doses of marmite will induce a rapid cure. Later, the addition of iron is generally necessary, as a latent iron deficiency may manifest itself at the higher blood levels.

To sum up: To prevent nutritional anæmia in pregnant women, and to ensure maximal good health for mother and child, the diet should contain an abundance of iron-rich foods—meat, fresh green vegetables, eggs and whole cereals, and, in addition, a ration of liver and kidney, so that there shall be no lack of the anti-pernicious-anæmia factor. If such a diet is beyond the means of the patient, then throughout pregnancy large doses of iron and some autolysed yeast preparation should be given and anæmia should vanish from the ante-natal clinic.

REFERENCES

1 Davidson, L. S. P., *et al.*, *Brit. Med. Journ.*, 1933 (i), 685.
2 Strauss, M. B., and Castle, W. B., *Amer. Journ. Med. Sci.*, 1932, clxxxiv, 655 and 663; 1933, clxxxv, 539.
3 Cruz, O., *Mem. Inst. Oswaldo Cruz*, 1934, xxviii, 287.

Professor James Young suggested that a committee should be set up by some responsible body to consider the whole question of the diet of the pregnant woman.

Dr. V. B. Green-Armytage said he did not believe that a low serum calcium was the obstetrical Pandora's box, for in acute osteomalacia, beri-beri, and sprue—diseases in which the serum calcium was at its lowest ebb—there were no symptoms other than those attributable to lack of calcium and vitamins. Although the anæmic mother gave birth to a baby with a normal red-cell count, the infant was prone to develop rickets. This suggested a congenital absence—or deficiency—of the anti-rachitic vitamin D, and should be remembered in all ante-natal and post-natal clinics, lest a generation of C3 children arrive. One-child sterility might be due in large part to the drain of pregnancy and the puerperium on the mineral basis of life. A shortage or lack of storage of metals affected most particularly that dynamo of function—the hypophysis.

Dr. S. K. Westmann referred to the gigantic experiment that took place in Germany in the years 1917, 1918-1919, when lack of proteins and fats had led to the starvation of the population. The children born during that period were slightly heavier than control children born in the period 1910-1912. A striking decrease occurred in the incidence of eclampsia. Just before the great war its incidence was about 2·0 per 1,000 births, while in 1918 it was 0·6, but in 1922 there was an increase up to 2·2.

Section of Ophthalmology

President—RANSOM PICKARD, C.B., M.S.

[*January* 11, 1935, *continued.*]

Depth-Perception Exerciser.—RANSOM PICKARD, C.B., M.S. (President).

The apparatus is a development of the depth-perception test shown at a meeting of the Section in 1933.[1]

In most cases in which one eye has been removed, or in which vision is lost in one eye, the remaining eye soon acquires enough depth-perception not to make mistakes in placing objects, or in actions which require accurate depth-perception. But there remain a proportion in which this faculty develops slowly, and it is to help these patients that this apparatus has been devised.

It consists of a metal plate having forty holes in each of which an inch of tubing has been soldered. In each tube is a piece of stout wire four inches long, fitting snugly but not tightly, so that it moves easily in the tube. At each end of the wire is a knob of solder, large enough to prevent the wire escaping from the tube. The plate is surrounded by a rim an inch deep, to prevent injury to the wires and tubes when packed. It is supported by four legs, four inches long, and can be placed on any side, resting on the rim and legs. One end of the wires is coloured, eight each with white, yellow, blue, green, and red, or any other convenient distinctive set of colours; not in groups but scattered irregularly. Except for these coloured ends, the instrument is black.

The method of using the apparatus is to place it on one side with the wires projecting towards the patient, who sits facing the wires at a convenient distance. With the butt-end of a pencil or other pointer he endeavours to strike the end of a wire with a thrusting motion, pushing the wire as far into its tube as possible. The disengaged hand must not touch the instrument or the stand on which it is placed; the muscle-sense would help greatly if this were done, and the exercise be made too easy and so less useful. If the wires are hit in colour groups it is harder than if the exercise is done by rows; it is harder to thrust in the black end of the wire than the coloured end. By moving the apparatus in various directions, the patient remaining still, the exercise can be carried out in almost any part of the field.

A record can be kept of the number of successful hits made, and so an idea of the results of the exercise obtained.

This apparatus can of course be used merely as a test of depth-perception, as in the former simpler apparatus. For this the coloured ends must project at various distances from the plate, the examinee asked to touch them with the butt-end of a pencil by colour groups, and the result recorded.

This method has proved to be a useful auxiliary test for malingering in patients having both eyes, one of which is said to be defective. If the test is made with both eyes open and then with the alleged defective eye covered, the examinee will do better with both eyes than with one, if he really sees with the alleged defective eye.

The principle employed in the apparatus is the coördination of the muscular movements used in placing objects with the visual perception of depth, it is a utilization of the method of trial and error by which the infant learns spatial perception.

[1] *Proceedings*, 1933, xxvii, 152 (Sect. Ophth., 6).

[*March* 8, 1935.]

CLINICAL MEETING HELD AT THE NOTTINGHAM AND MIDLAND EYE INFIRMARY.

Erythrocythæmia (Vaquez' Disease).—A. C. REID, M.D.

Mrs. B., aged 46, came to hospital May 18, 1934, having had inflammation in both eyes for about a month.

On examination.—Vision (right and left) = $\frac{6}{6}$; emmetropic; media clear; fundi normal. Condition diagnosed as "congestive conjunctivitis with little or no secretion." The eye condition was resistant to treatment with zinc lotion and silver drops.

General condition good. Florid well-nourished type. Was having treatment for "rheumatism." Tinted glasses gave some relief later.

In October, despite a change to lead lotion, the patient complained of "a feeling of tightness" in the eyes and chest. The heart was examined but nothing abnormal was discovered. A skiagram of the mediastinum also showed nothing abnormal.

On December 11 the vessels of the fundi were decidedly plus, both arteries and veins, which were easily distinguished. On January 9 a blood-count gave: R.B.C. 9,704,000; Hb. 110%; C.I. 0·56; diameter of corpuscles 6·86 μ. Since then under weekly dosage of phenylhydrazine the blood-count has come down to 7,904,000 by easy stages, and the feeling of tightness in the chest and burning of the eyes has disappeared. There have never been any hæmorrhages, even from the nose, nor has there been thrombosis in any part of the body. The patient is a Class-4 donor, i.e. universal, and I am told there is no reason why her blood should not be used after an interval of at least two days since the last dose of the drug.

Retinitis Proliferans.—A. C. REID, M.D.

George B., aged 30, first seen in October 1933, on account of "dust in the right eye." On external examination: only slight conjunctival injection was seen. Vision (right and left) = $\frac{6}{6}$. The patient did not return to hospital until April 1934 when he came with a history of a blow over the right eye a month previously and complained of some blurring of vision.

Vision (right) = $\frac{6}{9}$. A horizontally-placed film was noted coming from the back of this eye well forward into the vitreous and extending like a diaphragm, almost bisecting the vitreous into two unequal halves, the lower being the smaller. It was attached by bands to both outer and inner sides of the globe and a white plaque as of exudate was seen to the outer side. Left eye normal.

As it seemed a more or less stationary condition and vision improved to $\frac{6}{9}$ partly, the patient was seen only twice afterwards, until August when he came to hospital again saying that the vision in the right eye had failed suddenly.

Vision (right). = $\frac{6}{24}$. The condition was diagnosed in my absence as "retinitis proliferans" and treated with atropine till my return. The Wasserman reaction was negative.

On August 27 I noted as follows: "Condition much more extensive, with numerous vitreous opacities, retinal hæmorrhages and fibrous bands passing forwards to the sides of the film from exudative patches towards both right and left peripheries." The main horizontal film was permeated by innumerable fine vascular loops, but it was not possible to say if the circulation in these was active. No gross remains of a persistent hyaloid artery could be made out: only a fluffy patch, as of fibrous tissue, about half-way up the posterior capsule of the lens (slit-lamp).

He was given tuberculin in the form of T.R. injections, beginning with 1/20,000 mgm. once a week. Under this treatment he continued at work in a tobacco factory and the vision in the right eye improved to $\frac{6}{6}$ partly.

In November Miss Ida Mann kindly saw him with me and advised the continuance of this treatment. She considered the vessels as new, i.e. not fœtal remnants. She was convinced that there was active mischief (inflammatory) in the lower half of the retina. Since then T.R. has been increased to 1/5,000 mgm.

The eye condition shows only slight change; perhaps the fibrous bands are thicker and some fresh vascular loops have formed on the inner side below the plane of the original diaphragm. The exterior of the eye is normal. The left eye is normal. General condition good. There is no other evidence of tuberculosis in the body or definite family history of that disease. The vision in the right eye has diminished a little and is now $\frac{2}{3}$ (two letters only).

Conclusion.—The two inflammatory foci of a possibly tuberculous nature at the inner and outer sides of the retina, about 6 mm. behind the ora serrata, seem to have been the starting point of a vascular diaphragm extending right across the vitreous in the horizontal plane just below the level of the optic disc. The main part of this diaphragm remains very thin and appears to consist of loops of vessels only. At the outer and inner sides it is anchored by some fibrous bands, so that very little movement is evident. Deterioration, if any, is slow.

Aniridia.—N. P. R. GALLOWAY, M.B., Ch.B.

Mavis D., first seen in November 1929, when she was 13 months old. Brought up by her grandmother, who complained that her eyes had been "funny" and red since birth.

Patient is the eldest of three children. The two others (boys) have normal sight and there is no family history of defective vision. The parents are not blood relations.

Condition on examination.—Complete bilateral aniridia; hypermetropic, 8 in right, 10 in left; dotted diffuse lens-opacities with central denser opacity in the right eye; cornea clear.

Next seen, August 1932, when the grandmother stated that the child had been stumbling over everything recently. Tension raised in right eye, and cornea steamy. On examination under general anæsthetic, the left fundus was found to be normal, but the right fundus could not be seen owing to corneal haze and lens-opacity. A notch was found in the right lens downwards and outwards, and both lenses seemed small. Eserine, $\frac{1}{4}$% t.d.s., was given, but had a doubtful effect. Tonometry attempted on numerous occasions, but the child was too restless. In January 1933 tension seemed normal, and remained so for a time, though the right eye was inclined to diverge.

Patient was seen again in June 1934, when the right cornea was again hazy and tension was raised (? 100 Maclean). Projection of light seemed present. On June 20, 1934, a Herbert's short-flap sclerotomy was performed and tension seemed less for a time, but in November 1934 the tension was again noted as being raised. November 14: Maclean, right 100; left 30 to 40. On December 1 a Holth's punch-sclerectomy operation was performed, and in doing this the lens was injured, and by February 1935 had resorbed. The punch operation wound has healed up, and raised tension was again noted in the right eye in January. The right cornea is noted to be becoming larger, and the grandmother says the child is now complaining of headaches and is stumbling about. This child is somewhat defective mentally, and therefore difficult to examine.

February 1935: Vision (left) c + 6 sph. = $\frac{6}{36}$, or more (judged by tracing letters).

POSTSCRIPT: The eye was trephined on April 13, 1935, and some fluid vitreous escaped at the time. On May 1 the tension of this eye was minus, and the appearance suggested detachment of the choroid.

July 25, 1935: On July 3 the right eye was removed and a section was examined by Mr. F. Law, who has kindly supplied the following report:—

Macroscopic appearance: An opaque membrane stretches across in the position of the iris, of which the root is seen. The appearance is that of total detachment of the retina with cyst formation.

Microscopic appearance: The cornea is degenerate, thinned and infiltrated. The anterior chamber is irregular in depth and contains exudate. Dislocated degenerate lens remnants are seen in which bone formation has occurred. Organized fibrous connective tissue stretches across from the root of the iris on either side: the ciliary body is unrecognizable as such, and no ciliary processes are found. The retina is totally detached, degenerate, and drawn forwards in the position close behind this membrane: hæmorrhage and intraretinal cysts are present. The vitreous chamber is occupied by a hyaline exudate. The choroid is atrophic and sclerosed. There is pathological excavation of the optic disc and the optic nerve is hypercellular and atrophic.

Optic Atrophy in Two Brothers.—N. P. R. GALLOWAY, M.B., Ch.B.

I. R. W., a postman, first seen by me in July 1934, at the age of 43 years, when: R.V. $= \frac{3}{60}$ and Jaeger IV; L.V. $= \frac{3}{60}$ and Jaeger IV.

He complained of (1) frontal headaches since he was discharged from the army. These lasted for two days, and occurred two or three times a month; (2) blurring of both distant and near objects for a few minutes at a time, since 1917.

Examined under a mydriatic, the eyes were found to be myopic: R.V. c − 2 sph. $= \frac{6}{60}$ vix. L.V. c − 2·75 sph. $= \frac{6}{36}$, 1 letter.

Examined ophthalmoscopically, both discs are seen to be pale, with a faint yellowish tinge; the arteries are very small. Physiological cups are well marked.

It was then discovered that Dr. Thomson Henderson, to whom I am indebted for the following notes, had seen the patient in 1931. Vision with correction had been: R.V. $\frac{6}{18}$ partly, and Jaeger II vix. L.V. $\frac{6}{24}$, 1 letter and Jaeger I.

The blood Wassermann reaction is negative. The pupils react to light. The fields of vision are full peripherally, but there is a central colour scotoma. Patient is one of a family of 13. The mother died in childbirth, aged 40: the father is alive and well, aged 73 years. Only one other member of the family, Joseph (*cf.* below) has defective sight. The patient has seven living children, who have good sight.

History of failing sight.—States that at the age of 25 (i.e. in 1917) he had some difficulty in reading, and was given glasses, but his vision has been worse since Christmas 1933.

Report on general condition revealed nothing of importance in the nervous system or elsewhere. The visual fields are quite normal peripherally for one millimetre object at two metres, but he cannot recognize colours, and there appears to be a small temporal hemianopic scotoma in each eye during the fixation.

Cerebrospinal fluid: Clear colourless fluid with no coagulum. Under five white cells per c.mm; chlorides 0·73%; sugar normal; albumin 0·08%; no cells or micro-organisms seen in films; culture sterile.

Skiagram of skull.—Pituitary fossa small but regular in outline. No sign of tumour. Optic foramina normal. Right frontal sinus hazier than left. The appearance suggests infection. The maxillary sinuses appear to be normal.

He is the eldest of the family affected, and the other member of the family affected, Joseph, is the second eldest.

II. Joseph W.—First seen August 1931, complaining of difficulty with near vision for two years. R.V. $= \frac{5}{60}$, c − 4·5 sph. $= \frac{6}{12}$ vix; L.V. $= \frac{6}{60}$, c − 5·5 sph. $= \frac{6}{36}$. R.V. = Jaeger IV; L.V. = Jaeger V.

Pupils react normally to light. Examination of visual fields showed full peripheral fields to white on tangent screen, but absolute central colour scotoma. Normal blind spots.

Ophthalmoscopically examined, the arteries are seen to be small. The temporal third of the disc is pale. Wassermann reaction negative. Urine contains no albumin or sugar. Knee-jerks present. No Babinski reaction.

Oxycephaly.—N. P. R. GALLOWAY, M.B., Ch.B.

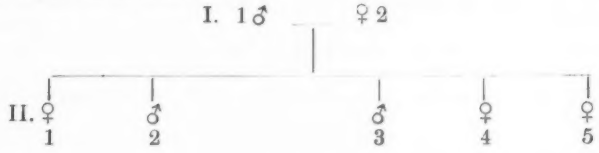
John A., first seen June 1934, aged 8. He had then a typical tower skull, with a small conical opacity projecting from the centre of the vertex (see photograph). The greatest circumference of the skull is 50·7 cm. as measured round the line of the superciliary and external protuberances. The greatest vertical height of either orbit appeared to be 32 mm. Jaw prognathous. Eyes diverge. Distance between lateral aspects of external angular processes of frontal bone is 9·8 cm. Greatest width of skull 13·6 cm.

Oxycephaly. Note the way the hair is arranged to hide the "knob" and the top of the skull.

Refraction under atropine showed three to four dioptres of myopia, but as the child is mentally defective it is impossible to say exactly what he sees. He would count fingers at three feet with the right eye, but does not fix with left eye. There is well marked nystagmus and optic atrophy of the primary type. The outlines of the disc are clear and the vessels normal in size. The atrophy appears the more marked in the left eye. The peripheral fields, as tested to the light of an ophthalmoscope, appear fairly full, and on peering very closely to coloured wools, &c., he can recognize the colours.

Skiagrams.—Irregular ossification of the bones of the skull suggest intracranial pressure. Pituitary fossa appears to be considerably enlarged. "Beaten silver" skull. Enlargement of pituitary fossa, with erosion of anterior and posterior clinoids.

Family history is as follows:—



I. 1. J. W. A. (father), aged 51. 2. (Mother), deaf twenty years. Old interstitia keratitis with myopia.

II. 1. Joan Elsie, aged 9 years. In asylum four years. Idiot. Poor sight and squint. Spastic paraplegia. Cannot articulate. Fundi not examined.
2. J. A., aged 8 (patient). Has never had any fits. At the age of 2 years he was seen by a physician, who reported that condition of oxycephaly was then present.
3. Arnold, killed when aged 6 years. Could not read; attended school one year.
4. Marjorie, aged 5 years. Speech not normal. Fundi normal.
5. Beatrice Elizabeth, aged 3 years.

[*June* 14, 1935]

Bilateral Conical Cornea with History of Acute Ectasia; Contact-glass Correction.—A. RUGG-GUNN, F.R.C.S.

I. C., a young man from South Africa, aged 22. Both eyes have been affected from the age of 12. Patient consulted Dr. Stutterheim of Johannesburg four and a half years ago, when R.V. = $\frac{4}{60}$: L.V. = $\frac{0\cdot5}{60}$ to $\frac{2}{60}$. There were no opacities in the right cornea, but fine central opacities were present in the left.

One year later the patient, on awakening one morning, noticed a film over the right eye and Dr. Stutterheim found a bulging milky opacity involving the whole depth of the apex of the cone. Under treatment the bulge disappeared but an opacity persisted and is still present. Three years previously a similar condition had affected the left eye.

February 1935: R.V. = $\frac{2}{60}$; L.V. = $\frac{1}{60}$. With appropriate contact glasses R.V. = $\frac{6}{12}$; L.V. = $\frac{6}{18}$.

Slit-lamp examination: Tracks of opacity appear to involve the whole thickness of the right cornea at a few points. The cone is thin and the endothelial surface is fairly regular. In the left cornea the opacities are mainly deep, lying close to Descemet's membrane. The latter is very irregular.

The patient received his contact glasses on March 18, and within a fortnight was wearing them for four hours continuously. In four or five weeks he was able to wear them for eight or nine hours, and lately he has worn them for twelve hours continuously.

The case is an interesting one in several respects. The sex is a little unusual, males being affected much less frequently than females. It is sometimes suggested that conical cornea is associated with vitamin deficiency, particularly vitamin D. I think that this can probably be ruled out in the case of a man born and bred in the sunshine of South Africa and, in any case, conical cornea has always been more prevalent among Latins than among northern races. Some obscure defect of nutrition is probably often present, as the condition frequently develops on recovery from some debilitating disease, e.g. enteric fever. In the present case, although he was rather thin as a growing child, no such antecedent can be traced.

The question also arises as to whether he has had rupture of one or both

corneæ. True rupture must be very rare; I have not succeeded in tracing a single non-traumatic instance. The condition here appears to have been the not uncommon one known as acute ectasia, which consists of a sudden infiltration of aqueous into the spaces of the substantia propria, forming an œdematous pad over the apex of the cone. Some years ago Mr. Goulden described such a case to the Ophthalmological Society, where true rupture very nearly occurred, as a descemetocele was present.

Attempts to correct defective vision in conical corneæ by some form of contact glass are not new. Almost a hundred years ago Nussbaum carried out some experiments on rabbits. He incised the cornea, undermined the edges of the incision, and inserted a small disk of glass which was kept in position with sutures. He stated that the glass was well tolerated and did not look too bad. About this time, i.e. the forties or fifties of last century, a good deal of interest was taken in corneal transplantation. Himly of Göttingen was particularly active, but the operation was also tried out in this country, in America and in France. The results were uniformly unsuccessful, and it was doubtless the failure of these efforts that suggested to Nussbaum the idea of glazing the cornea.

The problem of correction by ground contact glasses is exactly the same for conical cornea as for high myopia, and it is a problem, in spite of the success of the present case and others, that still awaits solution. The two principal difficulties are: (1) To avoid touching the cone; (2) to interfere as little as possible with the pressure conditions obtaining in the conjunctival sac.

As I pointed out some years ago the centre of the normal cornea is its most sensitive area. In conical cornea, however, the apex of the cone is relatively insensitive; usually it can be indented with a probe without causing much inconvenience. In spite of this it will not tolerate prolonged contact with glass, and, as the glasses which give the best correction both in conical cornea and in high myopia are the flat members of the series, avoidance of contact in these cases is attained with difficulty.

In a paper that I read before this Section in November 1931, I suggested a modification to meet this difficulty namely, the introduction of a broad zone, instead of the existing ridge, between the scleral sphere and the corneal sphere. About the same time Dallos of Budapest made a similar suggestion and Zeiss glasses of this 3-surface form are now obtainable. They have not, however, proved successful in practice. They have some of the faults of the small diameter (corneal) glasses used for the correction of aphakia. The upper eye-lid exerts greater pressure than the lower. Folds may be produced in the cornea. The lower edge of the glass is apt to be caught by the margin of the lower lid; the fluid runs out or the glass itself is blinked out. On Dr. Dallos' suggestion a further modification was introduced. In the last pattern the outer surface remained the same, i.e. 3-surfaced, but the inner surface reverted to the two surfaces of the original glasses. This modification has one great advantage; the glass becomes a lens, its refractive index being greater than that of tears, and can be used for correction.

Another factor emphasized by Dallos is the importance of the vertex depth, i.e. the relative convexity of the cornea measured from the scleral rim. This measurement considerably influences the correcting power and has to be taken into consideration. Dr. Dallos has devised a special apparatus, which he calls a tholometer, for its estimation.

The second difficulty is scleral, or rather corneo-scleral, because a contact glass rests on the cornea more than on the sclera. Spherical scleral curves are not practicable, as every eye is more or less aspherical in shape. Messrs. Zeiss are fully aware of this difficulty and offer to grind scleral curves to any shape desired and even to grind away special segments at points of undue pressure. It is not

always easy, however, to decide where this should be done and still less easy to incorporate the information in a prescription.

The scleral zone should be larger than in the present models, so as to distribute the pressure over a wider bearing surface. It should be narrow above and on the nasal side, and wider below and on the temporal side. It should not cause pressure on the capillary loops at the limbus and should interfere as little as possible with the normal pressure conditions prevailing in the conjunctival sac. At the last congress of the Ophthalmological Society Dr. Klein referred to the work of Dallos, who has now solved the problem of taking accurate moulds of the anterior eye-ball. I feel sure that the solution of the contact-glass problem lies along these lines. This does not mean that no eye can be fitted until a mould is made. It seems probable that eventually there will materialize from his measurements a series of standard shapes, from which adequately fitting scleral models may be selected to fit almost any eye.

I am glad to have this opportunity of paying a tribute to the work of Dallos. He has done work with respect to the clinical application of contact glasses ranking in importance with that of Hartinger on optical theory.

The present case has been corrected by ordinary double-sphere Zeiss glasses. Lately the patient has worn these repeatedly for twelve hours at a stretch without discomfort.

Discussion.—Mr. J. GRAY CLEGG said that he had recently seen a demonstration by Dallos in Budapest, during which that authority had explained that there were several forms of contact-glass. One was blown, but the corneal part was not accurately ground: that was unsatisfactory. Another was of the Zeiss type, with a distinct edge; the curve of the sclera and of the cornea was distinctly marked. Dallos said that each case had to be done individually; it was of no use to order a glass from Zeiss from any particular measurement. One material was used for making the negative mould, and a different kind of material was employed for making the positive, and on this he moulded the eyes himself. Dallos showed several patients who wore their glasses from morning till night with the greatest comfort. Some of these were high myopes. There were also other types. A great deal could be learned from Dallos' method, but it was important to remember that he carried out the actual moulding, or final fitting of the glasses, himself, in the case of each individual patient. The contact-glass was tight in one direction, and fitted loosely in another, in order to allow of movement of the globe.

Mr. A. G. PALIN said that in one or two of the cases in which he had carried out this procedure the patients had complained that when wearing the contact glasses everything was bright; some form of tinting seemed to be required. The ordinary contact-glass made the patient very uncomfortable when he went into a bright light, though he was fairly comfortable in ordinary conditions.

As to the length of time during which these contact glasses were worn, in the case which Mr. Rugg-Gunn had shown the patient had been wearing them twelve hours. He would like to know whether Mr. Rugg-Gunn had noticed a milky serous exudate, as he (the speaker) had found this in his own cases after the glasses had been worn for a few hours. If the glasses were removed for twenty minutes, washed and replaced, that exudate disappeared. He would also like to know whether Mr. Rugg-Gunn thought there could be any regression of the conical cornea after continued use of the contact glasses.

Mr. RUGG-GUNN (in reply) said that, with regard to the length of time the glasses could be worn with comfort, he always advised his patients to take them off every four hours, at the most, and, generally, he found that those who wore contact glasses chose meal-times for resting from them.

The mucoid deposit on the back of the cornea did not occur in every case, and he thought this must be dependent on some form of chronic conjunctivitis, or on osmosis due to diminished salt concentration in the fluid. If the contact glass was at all tight, this was much increased, and if it occurred during the first hour he took it as a sign that he was fitting much too tightly. He was sure that contact glasses did not cause regression of conus. Even in cases in which there was actual contact, as in the Dallos glasses, he had never known any note being made of regression.

A Pedigree of Congenital Optic Atrophy Embracing Sixteen Affected Cases In Six Generations

By A. Hugh Thompson, M.D., and G. T. Willoughby Cashell, F.R.C.S.E.

Abstract.—A family including six generations and 31 individuals is described. Sixteen were affected with congenital optic atrophy; in ten of these the condition has been verified by expert examination. Out of the sixteen, ten were males and six females, a sex-incidence differing considerably from that in Leber's disease. In our pedigree, inheritance is dominant and is always through an affected mother, never through an unaffected mother or through the father. In typical Leber's disease it is through an unaffected mother, i.e. it is recessive.

In the family now described, the optic atrophy appears to be stationary. In all the cases that have been seen the discs are white, with well-defined margins and no filling-in of the central cups, even in those cases that retain some useful vision. Instead of a central scotoma as in Leber's disease, there is peripheral restriction, in some cases severe, but in others only slight. No ring or paracentral scotoma or any colour scotoma have been demonstrated. Except the atrophic discs there are no definite ophthalmoscopic changes. Nystagmus is either constant or intermittent in nearly all the cases. No other congenital anomalies have been noted, either in the affected or the unaffected members of our pedigree, or are known to exist in any relatives. There is no consanguinity which might be a factor in the causation.

There are several recorded pedigrees of family optic atrophy differing from Leber's disease in some respects, but the only ones at all resembling ours are those of (1) J. M. Griscom and (2) Rampoldi. In (1) eight males and six females included in three generations had optic atrophy dating from early childhood. The inheritance was dominant but was through an affected father. In (2) seven members of a pedigree of four generations are presumed to have had optic atrophy inherited directly from an affected father in two cases, and from an affected mother in four.

Taken together, these instances suggest that there may exist a form of congenital or family optic atrophy in which inheritance is of the dominant type, which in some families is transmitted through the father only, in others through the mother, and in others sometimes through the father and sometimes through the mother.

Résumé.—Description d'une famille de six générations avec 31 individus, dont 16 étaient atteints d'atrophie du nerf optique. Dans 10 de ces cas l'état a été vérifié par un examen expert. Parmi les 16 cas il y avait 10 hommes et 6 femmes, ce qui représente une incidence pour les sexes très différente de celle qui existe dans la maladie de Leber. Dans cette famille l'hérédité est dominante, et la maladie est toujours transmise par une mère atteinte, jamais par une mère saine ou par le père. La maladie de Leber typique est transmise par une mère saine, c'est-à-dire, l'hérédité est récessive.

Chez la famille décrite ici, l'atrophie paraît être stationnaire. Dans tous les cas la papille est blanche, avec des contours bien marqués, et les excavations centrales ne sont pas remplies, même quand il y a un reste de vision utile. A la place du scotome central de la maladie de Leber on trouve une restriction périphérique du champ visuel, grave quelquefois, mais généralement peu importante. Ni un scotome paracentral ni un scotome annulaire n'a été observé. Avec l'exception de la papille blanche il n'y a pas d'altérations ophthalmoscopiques nettes. Le nystagmus est constant ou intermittent dans presque tous les cas. D'autres anomalies congénitales n'ont été observées ni chez les sujets atteints ni chez les sains, et ne sont pas non plus connues chez aucun parent. Il n'y a pas de consanguinité qui pourrait jouer un rôle causatif.

Plusieurs cas d'atrophie optique familiale différant sous certains rapports de la maladie de Leber, ont été rapportés, mais les seuls qui ressemblent au nôtre sont ceux de J. M. Griscom et de Rampoldi. Dans la première famille 8 hommes et 6 femmes, membres de 3 générations, étaient atteints d'atrophie optique depuis la première enfance. L'hérédité était dominante, mais la transmission était par un père atteint de la maladie. Dans la

deuxième famille 7 membres de 4 générations étaient supposés d'être atteints d'atrophie optique héritée directement du père dans deux cas et de la mère dans quatre cas.

Dans leur ensemble ces cas suggèrent qu'il existe une forme d'atrophie optique familiale ou congénitale avec une hérédité dominante, transmise dans certains cas par le père seul, dans d'autres par la mère seule, et dans d'autres encore par l'un ou l'autre des parents.

ZUSAMMENFASSUNG.—Beschreibung eines sechs Generationen und 31 Individuen umfassenden Stammbaumes. Sechzehn Mitglieder der Familie waren von angeborener Opticusatrophie befallen; bei 10 dieser Fälle wurde der Befund durch Untersuchung von kompetenter Seite erhärtet. Unter den 16 Kranken waren 10 Frauen und 6 Männer: diese Verteilung unter die beiden Geschlechter unterscheidet sich beträchtlich von derjenigen der Leber'schen Krankheit. Bei unserem Stammbaum ist die Vererbung dominant und zwar erfolgt sie stets durch eine von der Krankheit befallene Mutter, niemals durch eine gesunde Mutter oder durch den Vater. Bei der typischen Leber'schen Krankheit erfolgt die Vererbung durch eine gesunde Mutter, d.h. die Vererbung ist recessiv.

Bei der hier beschriebenen Familie scheint die Atrophie stationär zu sein. Bei allen Fällen, die wir gesehen haben, sind die Papillen weiss, ihre Ränder scharf begrenzt und die Excavation nicht ausgefüllt, auch nicht in solchen Fällen bei denen eine brauchbare Sehschärfe bis zu einem gewissen Grade erhalten war. Anstatt des bei der Leber'schen Krankheit gefundenen centralen Skotomes besteht hier eine—in manchen Fällen hochgradige, in anderen nur leichte—periphere Einengung des Gesichtsfeldes. Ring- oder Paracentralskotome sowie irgendwelche Farbenskotome wurden nicht gefunden. Abgesehen von der Atrophie der Papillen bestehen keine eindeutige ophthalmoskopische Veränderungen. Nystagmus, entweder kontinuierlich oder intermittierend, besteht bei fast allen Fällen. Andere angeborene Anomalien waren weder bei den befallenen noch bei den nicht befallenen Mitgliedern unseres Stammbaumes nachweisbar und waren, soweit uns bekannt, auch nicht bei irgendwelchen anderen Angehörigen aufgetreten. Ebensowenig bestand Konsanguinität, die eine ursächliche Rolle spielen könnte.

Mehrere Stammbäume von Familien, die an einer Art von familiärer Opticusatrophie litten, welche sich in mancher Hinsicht von der Leber'schen Krankheit unterscheidet, sind beschrieben worden, aber die einzigen Fälle, die dem unsrigen irgendwie gleichen, sind die von J. M. Griscom und die von Rampoldi beschriebenen. In dem von Griscom veröffentlichten Fall waren 8 Männer und 6 Frauen aus 3 Generationen im frühen Kindesalter an Opticusatrophie erkrankt. Die Vererbung war dominant, erfolgte jedoch durch einen erkrankten Vater. Rampoldi beschreibt 7 Mitglieder aus 4 Generationen mit Opticusatrophie, bei denen die Annahme gemacht wurde, dass die Krankheit in 2 Fällen direkt von einem befallenen Vater, in 4 Fällen von einer befallenen Mutter vererbt wurde.

Fasst man diese Beispiele zusammen, so ergibt sich der Hinweis, dass es anscheinend eine Art angeborener oder familiärer Opticusatrophie gibt, die dominant vererbt wird, u.zw. erfolgt die Vererbung in einigen Familien ausschliesslich durch den Vater, in anderen durch die Mutter, in wiederum anderen manchmal durch den Vater und manchmal durch die Mutter.

I.—Mr. Hugh Thompson

This pedigree of six generations includes thirty-one individuals, ten of whom are blind or partially blind from optic atrophy, six of whom were blind, presumably from the same cause, and fifteen of whom are either normal or were so while living, so far as is known. Three years ago, a pedigree was published by Mr. E. A. Dorrell [1], and this included seven of the affected cases in the latest three generations. It also included one member of Generation V. (V. a.1) who was not then known to be affected. To Mr. Dorrell we are indebted for supplying this information. With one exception, all the members of the last two generations are living.

In addition to these, we now have information of three earlier generations in which three ancestresses of the family shown here to-day appear to have been affected, as well as at least two females in a collateral line, all of them alike descended from an old lady (I. 1) of whom, unfortunately, we have been able to obtain no information

except that she was blind, and lived to the age of 90. Her great-granddaughter (IV. 1) remembers her and that she used to knit coloured quilts.

Generation II.—The same authority—Mrs. Perrin (IV. 1)—who is present to-day, states that her grandmother (II. 1) was also blind. She cannot remember her maiden name, but her first husband was named "*Gerard*," her second "*Pitman*."

Generation III.—Of Dinah Gerard's (III. 1) blindness, we have good evidence both from her daughter, Mrs. Perrin (IV. 1), our chief informant, and from other members of the family. She married a man named "Townsend," who also became blind through an accident. The Pitman family—her half brothers and sisters—consisted of two sons, both normal, and "several" daughters, who are said to have been blind. Mrs. L. (the oldest of Gen. V.), says that her grandmother used to say that all the girls in their family had defective sight. In our pedigree we have assumed that two were affected (III, b. 3 and 4). It was thought that there was a

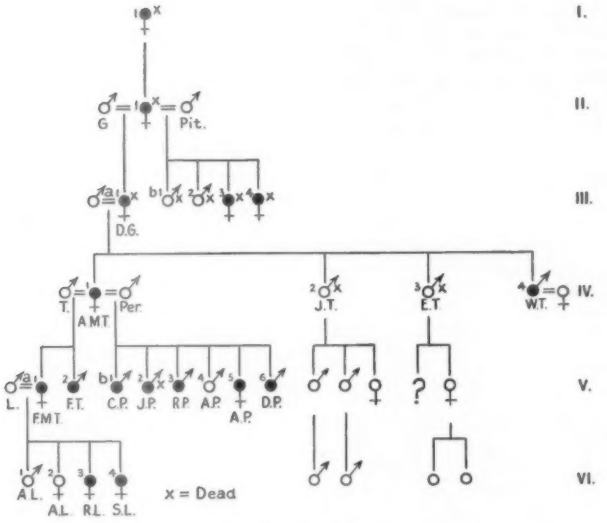


CHART I.

blind member of the Pitman family now at Swiss Cottage Blind School, and there was a girl of that name recently there, but I find that her blindness is due to double detached retina, and she has no knowledge of her ancestry, so that we actually know nothing of the inheritance of the Pitman family. So much for the three first generations. We cannot, of course, pretend that the evidence with regard to them is at all on a par with that which we possess of the last three, of whom we have full notes of all the affected members, except two in the fourth generation who are dead, and their descendants, and one in the fifth who emigrated to Canada.

Coming then to *Generation IV*, the first, A. M. T. (IV. 1), is alive and here this afternoon. She has optic atrophy; fundi otherwise normal; vision reduced to hand shadows in either eye. She has marked nystagmus. Her father was named "Townsend," and the father of her first family—a third cousin—was also named "Townsend." Her own sight was very defective from birth, but she went to an

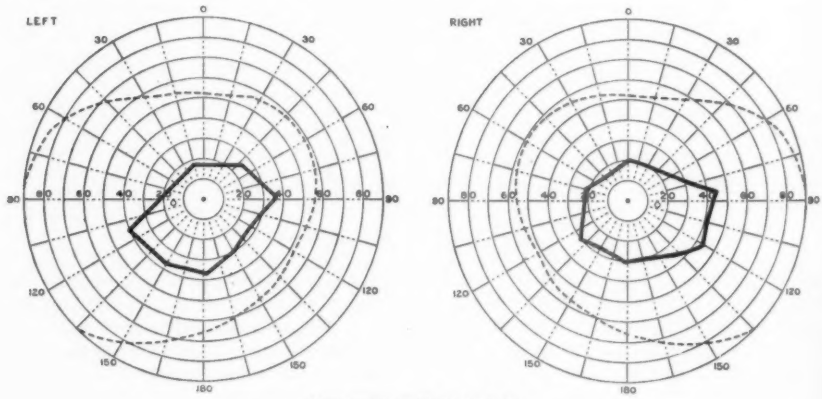
ordinary school, and afterwards went into service as a house parlour-maid. When she was 26, she married a man named "Perrin," who died in 1918, as the result of war service. She was seen at Oxford Eye Hospital in 1923 [1], then aged 44. For thirty-six years she had been unable to read and could only just find her way about. She had coarse, jerky nystagmus and atrophic discs. She tells me that Mr. Nettleship came to see her many years ago, and that he was much interested in her family history. It was when she was a young woman and before she had most of her present family. I can find no pedigree that looks as though it might have been hers in the appendix to the Bowman lecture where all the pedigrees of Leber's disease known to Mr. Nettleship are given. She had two brothers with good sight, J. T. (IV. 2), who died of cancer in 1931, and E. T. (IV. 3), who died of septicæmia in 1925. The former had two sons and a daughter, the latter two daughters. None of these were affected. They are shown on the chart, and also four infant grandchildren of IV. 2 and IV. 3. So far as is known these are all normal.

A third brother, W. T. (IV. 4), is still alive and has optic atrophy. He will be more fully described by Mr. Cashell.

Generation V.—A. M. T's. first family consists of a daughter F. M. T. (V. a.1) whose husband is named "Lewendon." She is one of the affected patients shown here and will be described by Mr. Cashell; also a son, Frederick T. (V. a.2), who is the one mentioned already as being in Canada, and not heard of for more than nine years, but said by his mother to have been nearly blind.

Her second family includes six, all but one of whom are more or less blind from optic atrophy and all living except one.

Charles P., (V. b.1) aged 28, is here to-day. Vision right $\frac{1}{60}$, left $\frac{2}{60}$. Pupils react. H. Astig. about + 1, but glasses do not improve. Constant nystagmus. Discs white atrophy, but a peripheral ring of slight colour present just inside the margin. Arteries small. Rest of fundus normal. Fields very contracted peripherally, but no scotoma. Colour vision very defective. He was seen at



Charles P. (V. b.1) 16.5.35.

Oxford Eye Hospital, aged 9, in 1916 [1]. "Vision: fingers at 3 metres, horizontal nystagmus. Discs almost white, arteries small." He was educated at blind schools, first at Southsea from aged 5 till aged 16, then at Leatherhead till aged 19½. He thinks he saw a little better about the age of 16. In August 1934 he came to

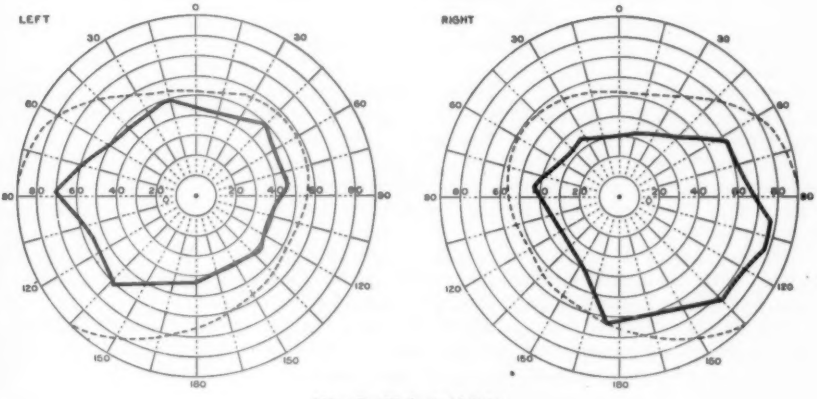
Swiss Cottage, where he is training for the basket making. He can find his way about well.

Joseph P. (V. b.2), seen at Oxford in 1916 (aged 7) where the notes are: Pupils equal and active vision less than $\frac{6}{60}$ each eye; nystagmus. Both discs white, arteries small [1]. He attended Southsea Blind School, and died by drowning at the age of 7.

Reginald P. (V. b.3), aged 24, seen at his mother's home in Newbury. Pupils react. Discs white. Rest of fundus normal. Vision fair, quite $\frac{6}{24}$ each eye. Nystagmus. Fields, roughly taken, show no scotoma and fair peripherally except for possibly some contraction in right lower part of field. He was seen at Oxford in 1916, aged 5. "Vertical nystagmus with sudden jerky movements. Discs atrophic" [1]. He was at Leatherhead Blind School and is now on the roll of blind workers as a basket-maker.

Alfred P. (V. b.4), aged 22. The only normal member of the sibship. He has supernormal vision ($\frac{9}{4}$) and some hypermetropia. Fundi normal.

Alice P., aged 20 (Pedigree V. b.5). Vision: right $\frac{6}{24}$, left $\frac{6}{24}$, but does not see so well when she is tired. Nystagmus only intermittent. Emmetropia. Discs atrophic though a faint redness is present in a ring just inside the margins, as in the case of her eldest brother. Arteries small. Rest of fundi normal. Fields nearly full. No scotoma. Good colour vision.



Alice P. (V. b.5) 16.5.35.

From the age of 7 till the age of 16 she was at a blind school at Southsea. At the age of 8 in 1923 she was seen at Oxford Eye Hospital, and the note made: "Irregular rotary nystagmus. Discs brilliant white. Vessels fair size" [1]. At the age of 16 she was sent out of the blind school for "too much sight." She then trained for domestic service at Hitchin for ten months, but at the age of 18 (1933) was certified again for blind training by Mr. G. W. Kendall who found vision $\frac{6}{60}$ each eye, and contracted fields. She has been training as a machine knitter at Swiss Cottage for the last two years and is due to leave at the end of this summer.

Dennis P., aged 13 (V. b.6), blind from birth, now at Exeter Blind School, seen in 1923 at Oxford, then aged 18 months. Then nystagmus and purposeless movements of the eyes (Oxford Notes).

In *Generation VI* there are one boy and three girls. The boy and the first girl are normal. The two latest-born girls are affected (Mr. Cashell's cases).

Summing up: Affected members of the pedigree, sixteen, of whom ten have been verified by expert examination. Not affected fifteen, of whom three have been verified by expert examination. Of the affected, six were male and ten female. Of the normal, eleven were male and two female, and two sex unknown. Only one of the normal females has been verified by expert examination.

Mr. Nettleship expressed the opinion that the exceptional cases of congenital familial optic atrophy recorded in literature were probably instances of atypical Leber's disease [2].

Our pedigree differs from typical Leber's disease in the following particulars:—

(1) *Age of onset.*—All our cases of whom we have accurate knowledge are congenital.

(2) *Sex incidence.*—In the whole pedigree, out of sixteen cases affected, six were male and ten female. Of the cases actually seen by an ophthalmic surgeon five are male and five female. The ratio is, therefore, approximately equal as opposed to the ratio in Leber's disease where males are largely predominant.

Nettleship's figures for Leber are 300 males to 60 females.

Miss Julia Bell has collected 1,182 records of Leber's disease in 240 pedigrees [9], including 32 from Japan. In the Europeans 84·8% of the affected are male, but in the Japanese only 59·1% are male.

(3) *Inheritance.*—In our pedigree, inheritance is always through an affected mother, but never through an unaffected mother, or through the father. In typical Leber it is through an unaffected mother, i.e. typical Leber is recessive and sex-linked; in our pedigree the inheritance is dominant.

(4) *Prognosis.*—In our pedigree the condition appears to be *stationary*, or, at any rate, approximately so. Of Leber's disease, Nettleship says, "With our present knowledge, I am sure we not only may, but should, speak hopefully about any case seen within a couple of years of the onset or even longer" [3].

(5) *Optic discs.*—In all our cases that have been seen, the discs are white, sometimes startlingly so, with well-defined margins and no filling in of the central cups. This is so even in those who retain some useful vision, as in: V. a.1, V. b.3, V. b.5, and VI. 3.

In the case of V. a.1 (cf. drawing), they bear a strong resemblance to the type of disc with intramarginal cups pictured in *Trans. Ophth. Soc.* for 1920, p. 336, but there is not and never has been any symptom of glaucoma.

(6) *Fields.*—Instead of a central scotoma, as in Leber, there is peripheral restriction, in some cases very severe, but in others (V. b.3 and V. b.5) only slight. No ring or paracentral scotomata have been demonstrated, or any colour scotoma, although C.P. (V. b.1), who can see to get about, has very defective colour vision.

In all our cases, except perhaps the two youngest children in the sixth generation, nystagmus has been either constant or intermittent. Except the optic atrophy and narrowing of vessels in some cases, there are no other definite ophthalmoscopic changes. No other congenital anomalies have been noted either in the affected members of our pedigree, or in the unaffected, or are known to exist in any relatives. There is no consanguinity except that the name "Townsend" appears both in the third and the fourth generation. The father of A. M. T.'s first family was her third cousin, but this fact appears to be immaterial.

There are several recorded pedigrees in the literature of family optic atrophy, differing from typical Leber's disease in some respects, many of them showing early onset, but the only pedigree at all resembling ours that I can find is that of J. M. Griscom [4]. (Chart II, p. 51.)

Here in a pedigree of three generations of congenital optic atrophy, comprising 32 known individuals, 14 were affected, of whom 8 were male and 6 female.

All the cases date from early childhood, and are presumably congenital. So far the pedigree resembles ours, and in both pedigrees the inheritance is always continuous without skipping a generation, i.e. of the dominant type. But whereas in our pedigree inheritance is always through an affected mother, in Griscom's it is always through an affected father. The nerve atrophy was always white and there were slight pigmentary disturbances and atrophic vessels. There were also, in this family paracentral or annular scotomata, never the central ones typical of Leber.

There is also a pedigree published by Rampoldi so long ago as 1883, in an Italian Journal [5]. (Chart III.) It is referred to in the "Kurzes Handbuch" in an article by Franceschetti [6], and also by Nettleship in his appendix [7]. Nettleship's

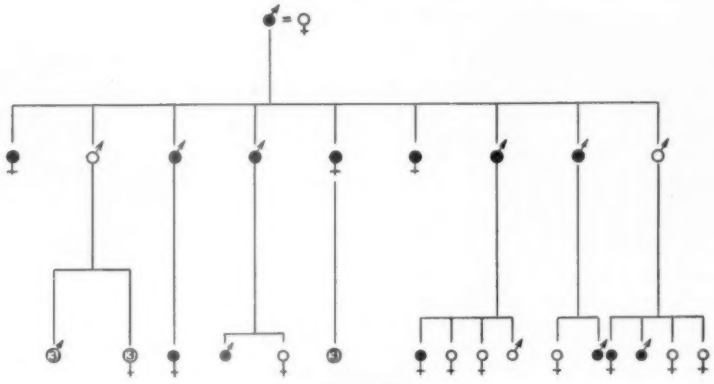


CHART II.

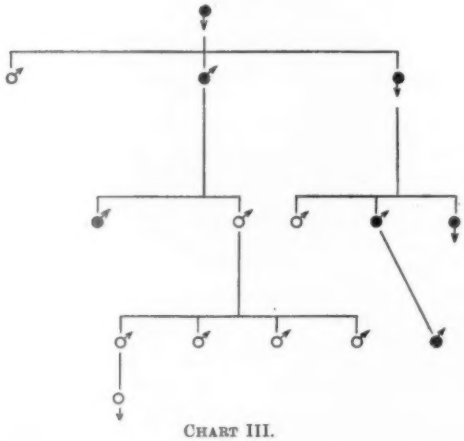


CHART III.

interpretation appears to be the more correct. In this family four generations appear to have been affected, but only one of the affected members has been examined by an ophthalmic surgeon; many of the others having been reported blind from a diagnosis which is now obsolete, but which in its time must have done yeoman service to many a puzzled ophthalmologist—"gutta serena." If all the cases were of the

same nature as the one member of the family seen by Rampoldi, the pedigree is one of family optic atrophy, but appearing in middle or late adult life. It is probably a pedigree of true Leber's disease affecting seven members in four generations, the proportion of males to females being five to two. The mode of inheritance, however, is continuous, i.e. dominant, the disease having been inherited from an affected father in two cases and from an affected mother in four.

Franceschetti gives this pedigree as an instance of congenital optic atrophy. Possibly it may form a connecting link between our pedigree and Griscom's. If so, it would tend to show that there is a form of congenital or family optic atrophy in which the inheritance is of the dominant type, which in some families is transmitted through the father only, in others through the mother, and in others sometimes through the father and sometimes through the mother.

The late Mr. Marcus Gunn [8] describes a pedigree in which a mother and two children, one son, aged 4, and one daughter, aged 8, had optic atrophy, without central scotoma. In the discussion the late Mr. Robert Doyne spoke of a similar case in which a mother and two sons were affected when young. These may have been pedigrees similar to our own but, the numbers of affected members being so small, we cannot be sure.

In Griscom's pedigree there is one instance of inheritance from an unaffected father. In no other case, in any of these pedigrees, is there a case of inheritance from an unaffected parent, either father or mother.

Three of the Japanese pedigrees collected by Miss Julia Bell [9] show continuous inheritance through the mother (Nos. 992, 926 and 929). In each instance three generations were affected, and in each the sex of the affected members was sometimes male and sometimes female, but in only one of these pedigrees does the affection appear to have been observed in childhood, and there is nothing to show that these pedigrees did not conform in most respects to Leber's disease, in which category Miss Bell includes them.

Among published pedigrees, therefore, ours appears to be unique.

II.—Mr. G. T. Willoughby Cashell

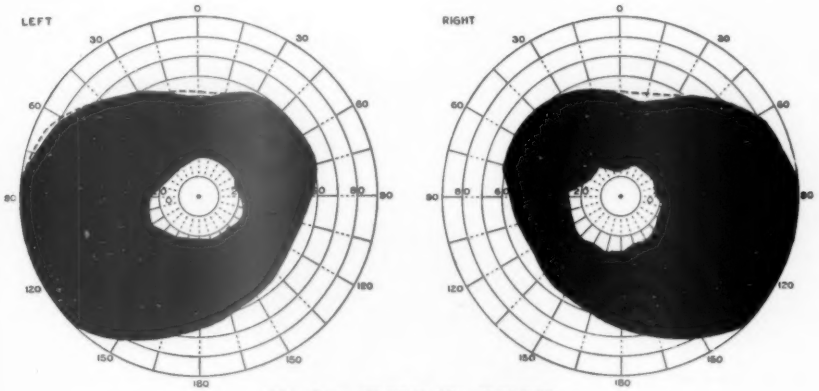
I have seen four of the members of this family in my out-patient department, at the Royal Berkshire Hospital, Reading.

W. T. (IV. 4), aged 52, the fourth member of the fourth generation, is married, but has no children. He works as a basket-maker at Newbury. He was treated at the Royal Berkshire Hospital in 1933, for hæmorrhoids, after a history of bleeding per rectum for five years, and while in hospital his blindness was noted and he was referred to the Eye Department. He stated that his sight had been getting worse gradually since infancy and on examination the vision was found to be $\frac{1}{60}$ in each eye, the pupils were active to light but the reaction was not maintained; there was a continuous oscillatory nystagmus, the optic discs were dead white, the retinal vessels were rather attenuated and the visual fields were very constricted. His refraction showed myopic astigmatism and the vision was not improved with glasses.

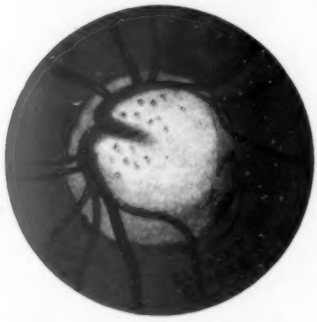
F. M. T. (V. a.1), aged 32, is the eldest child of the first family in the fifth generation[1]; she brought her third child, R. L. (VI. 3) to me for examination (1933), and at the time her own poor vision was commented upon and she agreed to an examination. She is married and has four children; the eldest two are healthy and have normal eyes, the younger two will be referred to later. The husband is healthy. The vision in this case is $\frac{6}{24}$ in each eye with glasses to correct mixed

[1] In the Reading pedigree she is tabled as unaffected, but her mother states that she was affected from birth.

astigmatism. She can manage quite well to get about and do her housework and bring up the family. The pupils react briskly to light, but do not maintain the contraction. There is a fine nystagmus and a divergent strabismus. The visual fields are very constricted, there is no evidence of any scotomata. The optic discs are dead white. She states that her vision has been getting worse lately, but that it had always been poor at school. She had to sit in the front of the class, and was not allowed to do fine needlework. She is an intelligent woman and interested in



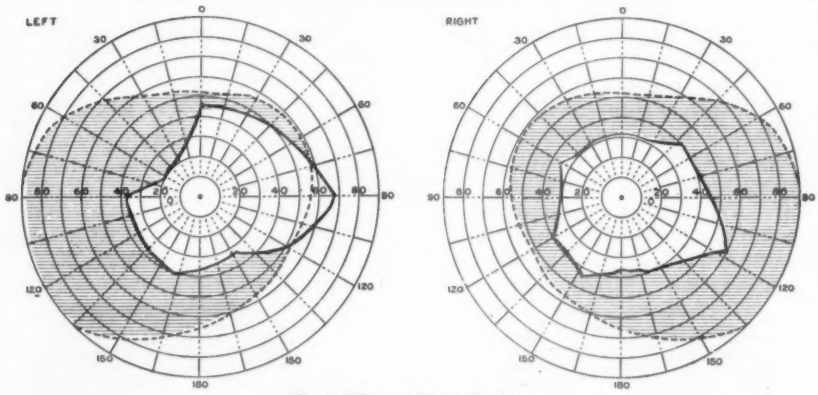
Mrs. Lew. (F. M. T., V. a.1) 10.5.35.



F. M. T., V. a.1.

the family history. She was a great help in sorting out the relations. In 1934 she applied to the hospital for sterilization on her own initiative, to prevent further blind children being born to the family.

R. L. (VI. 3) aged 5, is the third child in the sixth generation. She was first seen by Mr. Dorrell in 1931, and I have seen her again recently. She has a vision of about $\frac{6}{36}$ in each eye, the refraction is hypermetropic, she does not appear to notice near objects around her, but can pick out large objects in the distance fairly well. She is bright and intelligent and has a good memory, and her mother thinks that the vision is improving a little. The optic discs are dead white, the pupils are active, but do not hold contraction well, the retinal vessels are rather attenuated and there



Rachel Lew. (VI. 3) 10.5.35.

R. L., VI. 3.

is a divergent strabismus, but there is occasional nystagmus and coarse wandering eye movements.

S. L. (VI. 4), aged 2, is the youngest member of this family. She is bright and cheerful, answers quickly and repeats words readily. She falls over things at home

S. L., VI. 4.

The illustrations of the three discs do not show adequately in a monochrome text figure the whiteness shown in the original coloured drawing.

and always looks in the direction of a sound. but she follows a bright object or a light easily. She has some hypermetropic astigmatism, there is occasional nystagmus and wandering movements of the eyes. The pupils react well, but dilate again, the optic discs are dead white and the rest of the retina shows rather a granular appearance towards the periphery.

The results of all investigations—such as X-ray examination of the skull and the pituitary region, blood-examinations, Wassermann tests—have proved normal or negative.

I agree with Mr. Thompson that we are dealing here with a family showing hereditary congenital optic nerve atrophy, in which the disease is conveyed to each generation by an affected female and affects both the males and the females in the family. It is not, in my opinion, anything like Leber's disease.

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2 *Trans. Ophth. Soc.*, 1909, xxix, 120.
3 *Ibid.*, 110.
4 *Am. Journ. Ophth.*, 1921, iv, 347.
5 *Ann. di Ottalmol.*, xii, 1, 269.
6 "Kurzes Handbuch der Ophth.," Berlin, 1930, i, 801.
7 *Trans. Ophth. Soc.*, 1909, xxix, 184.
8 *Ibid.*, 1907, xxvii, 221.
9 "Treasury of Human Inheritance," 1931.

Discussion.—Mr. J. GRAY CLEGG asked whether the nervous system of these patients had been examined, and if so, whether there was anything in that to throw light on the condition.

Mr. HUGH THOMPSON (in reply) said that the patients had only been subjected to ordinary observation; there had been no expert neurological examination, but apparently there was nothing amiss in the central nervous system.

Mr. CASHELL (in reply) said that he had investigated his cases neurologically, but could not find any other abnormality in the nervous systems.

The Use of Adrenaline in Atropine and Hyoscine Irritation

By EUGENE WOLFF, F.R.C.S.

MOST ophthalmic surgeons have had cases in which the use of mydriatic was imperative and yet atropine and hyoscine, duboisin, &c., all caused irritation. Many suggestions have been put forward to overcome this. Sometimes changing the supply of the drug by going to a different chemist may be successful. Quite recently Waller (*Trans. Ophth. Soc.*, 1934, liv, 96) has shown that it is possible to immunize patients against atropine irritation by injecting subcutaneously and repeatedly a combination of atropine and protein in the form of tears. This, however, may take some weeks to take effect and in the interval it may be necessary to continue the use of the mydriatic.

A simple expedient may be of great help as it was in the following case:—

A patient who had been needled after a cataract extraction got atropine and hyoscine irritation. The skin of the lids was dry, red and swollen. Guttæ adrenaline 1/1,000, were dropped into the conjunctival sac and on to the skin of the lids over which they were spread with cotton-wool. Zinc oxide cream was applied to the lids and then the hyoscine was put in. Next day the skin was practically normal. By this means the use of hyoscine was continued for one week without the irritation reappearing.

In three cases of atropine irritation in iridocyclitis and one in a corneal ulcer the application of adrenaline almost immediately caused the irritation and swelling of the lids to disappear. In two cases in which the lids were so œdematous that

the eye could hardly be opened, within a short time (i.e. 10 to 15 minutes) after the application of the adrenaline there was a remarkable improvement and the patient opened the affected eye quite well. The symptoms, however, tended to return after a while, so the adrenaline was followed by the usual zinc-oxide ointment, and this combination, as shown above, was much more effective than the ointment alone.

In these cases the irritation occurred at the end of the disease and no attempt was made to continue with the mydriatic. It is therefore impossible at the moment to tell in what percentage of cases the adrenaline may enable one actually to carry on with the mydriatic. There can, however, be no doubt as to its immediate effect or the symptoms.

So far as I know there is no mention in the literature of adrenaline being used in atropine irritation. Hence the reason for this short note.

It is, of course, quite well known that adrenaline is of great help in the treatment of many allergic diseases. Its use in atropine irritation may be further evidence that this, too, is an allergic phenomenon.

Mr. COGAN said that as Ophthalmic Surgeon to the Kent and Sussex Hospital, Tunbridge Wells, he had been carrying out skin tests on six cases which showed irritation after the use of atropine and hyoscine: The usual mydriatics had been injected intradermally and all cases showed positive urticarial reactions while the control saline injections remained negative. This urticaria proved troublesome so he injected the urticarial regions with adrenaline which was followed by prompt subsidence of the urticarial wheals. This had led him to instil adrenaline drops, 1/1,000 thrice daily, into the conjunctival sacs of patients who were liable to mydriatic irritation and in consequence no sign of mydriatic irritation had been seen.

Section of Laryngology

President—W. M. MOLLISON, M.Chir.

[*May* 3, 1935]

Chordoma of the Base of the Skull.—GAVIN LIVINGSTONE.

Chordoma is the name applied to tumours derived from remnants of the notochord and it is a very rare condition. In 1926, when two papers were produced on the subject, only 57 cases had been reported and in about half of these the tumour was in the sacral region.

The recognition of these tumours dates from the work of Müller, who confirmed the conclusions arrived at in 1858 by Luschka and Virchow. The histology and evolution of the tumours were further elucidated by Peyron in the early part of this century, and comprehensive reviews on the subject were written by Stewart in 1922, and by Stewart and Morin in 1926. A case was published in the *Journal of Laryngology and Otology* in 1926 by Syme and Cappell from Glasgow.

Anatomical Considerations (See fig. p. 44).

The notochord begins in what corresponds to the head end of the embryo and extends caudally as the trunk is developed; it is derived from the axial mesenchyme which proliferates from the front end of the primitive streak. The primitive notochord sinks into the endoderm but separates from it at the cranial end. The disappearance of the notochord begins in the second month of fœtal life, the bodies of the vertebræ form around it and constrict it. The parachordal cartilages are transformed at a later date into basioccipital and basisphenoid bones.

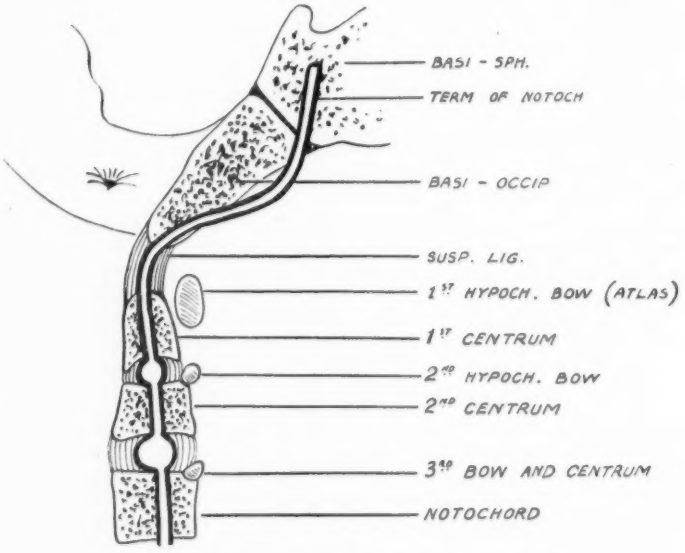
The notochord persists in the intervertebral discs where it swells up and forms part of the central core. The notochordal element escapes envelopment by cartilage and bone in three places at the cranial end: (1) Between the cartilage and perichondrium of the dorsum sellæ; (2) above the occiput towards the odontoid process; (3) between the base of the skull and pharynx. These elements usually disappear or else are quiescent. The consensus of opinion is that chordomata have their origin from these adventitious remnants at the cranial end of the body and not from the intervertebral disc remnant, growths of which are extremely rare.

The clinical picture of a chordoma depends on whether the growth extends upwards into the skull or downwards into the nasopharynx. The intracranial type perforate the dura and may cause pressure symptoms but do not invade the brain.

The present specimen was removed from a female patient, aged 28. She was referred by Dr. David, of Fyfield, Essex, to Mr. F. J. Cleminson, at the Middlesex Hospital, and I am indebted to Mr. Cleminson for permission to report the case. The patient complained of slight discomfort in swallowing and of being "run down." A

large tumour was found attached to the posterior wall and roof of the nasopharynx; it was not pedunculated. The surface was smooth and covered by mucous membrane and on the lateral margins slightly lobulated. The consistency was firm but not hard. An attempt to aspirate yielded a little gelatinous material. When taking a portion for section the mucosa stripped easily over the lower part. This section showed fibrous tissue only. Radiography did not show any erosion of the bones forming the pharyngeal vault or other abnormal signs.

In July 1933 under a general anæsthetic the soft palate was divided in the midline and a large portion of the growth exposed. A further piece was removed and sent for examination. The pathologist reported "an ill-defined mucoid non-malignant growth." It was found to be impossible to shell out the tumour from its



Diagrammatic representation of notochordal remnants.

capsule because of adhesions and it was decided to implant some radium needles; two containing 2·5 mgm. and three containing 1·5 mgm. were embedded with the silk threads brought out through the right nostril. These needles were left in position six days, which gave a total dose of 1,368 mgm. hours. There was little operative disturbance and the tumour rapidly diminished in size and in seven weeks had disappeared. On further X-ray examination no change was noted and there was still no involvement of the base of the skull.

In April, nine months later, the patient returned complaining of pains in the upper part of the back of the neck and over the occiput, usually aching in character but occasionally acute. Examination of nose and sinuses revealed nothing abnormal and no recurrence was seen in the post-nasal space.

In June, two months later, the patient was admitted to hospital on account of a short history of morning vomiting and diplopia. She had also had vertigo, dysuria

and tinnitus. These symptoms became worse and on neurological examination a diagnosis was made of a tumour of the base of the brain. There was no papillœdema; visual acuity was good; the optic fields and all eye movements were normal. The corneal reflex on right was diminished and there was nystagmus, more marked to the left. Both labyrinths gave normal responses to cold caloric stimulation. All deep reflexes were exaggerated and a double plantar extensor response was elicited. There were no abnormal cerebellar signs apart from the nystagmus. The Wassermann reaction was negative and the blood-pressure 118/78. The vomiting and headache increased and the patient died, thirteen months after the insertion of radium.

Post-mortem appearances.—The convolutions of the brain were flattened and there was a marked indentation on the inferior surface of the pons, caused by a pedunculated tumour two inches in diameter, growing from the basi-sphenoid. The underlying bone was eroded and replaced in part by soft hæmorrhagic material. The post-nasal space was macroscopically normal.

The histological picture was made up of large cells suggestive of "fat granular" cells; frozen sections showed these to contain doubly refractile lipoids. The stroma was œdematous, enclosing material which varied from groups of epithelial cells to an almost acellular collection of mucin. Hæmorrhages of all ages were seen and the vessels were well formed.

Chordomata have been divided into three types, depending on the stage of embryonic development.

Type I.—The small tumours called by Virchow "ecchondrosis physaliphera," They occur in 2% of post mortem examinations, and are composed of the same type of cells as in the nucleus pulposus of the intervertebral disc.

Type II.—The malignant tumour in which active mucin producing cells predominate and in which recurrences and metastases occur. The present case belongs to this group.

Type III.—The main feature in this type is the production of cells which resemble cartilage and the tumours are usually encapsulated and do not recur after removal.

The pharyngeal growths occur in younger people, cause more symptoms, and are more malignant than the sacrococcygeal type; the average length of life in the former type is three years, against seven years in the latter.

The interesting points in this case are the rapidity of growth and the sensitivity to radium. The dose given was not large but the visible tumour melted away. The growth in the basi-sphenoid did not receive an adequate dose and in a short time extended upwards into the skull.

A course of distant radium treatment followed by needle implantation should be tried before recourse to major surgery. Diathermy of a remaining nodule can be easily performed at a later date.

At the Middlesex Hospital, Mr. Blundell Bankart has a case of sacrococcygeal chordoma which was treated in 1930 with radium needles and since then with two courses of deep X-rays. The patient is alive and well, although there are some (?) secondary nodules in the skin. Sir Henry Newlands reports a case of chordoma which did not improve with X-ray treatment.

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Tuberculoma of the Nasal Septum.—MYLES L. FORMBY.

Female, aged 59. Nasal obstruction for two months; right side worse than left Has had sores in the nose for years and for the past six months has had slight bleeding. No pain. Flat granular tumour involving anterior part of the septum on the right side, blocking anterior nares. Left side, similar smaller projection towards floor of the nose. Wassermann reaction negative. A microscopical section shows chronic inflammatory tissue with giant cells of tuberculous type.

It is perhaps debatable whether I ought to have called this a case of tuberculoma or one of lupus of the nose. I called it one of tuberculoma because it resembled another case in which there was definite tuberculosis in both knees and an elbow-joint.

Discussion.—HERBERT TILLEY said that at a meeting of the Section a few years ago the late Mr. Wharry had shown several cases of lupus which he had treated successfully by means of radium needles.[1] He (the speaker) thought that it would be well to try that method in the present case before adopting any radical procedures.

E. D. D. DAVIS said that he had had two such cases, in which he had completely excised the affected area, afterwards treated any recurrence by the galvano-cautery, and they did well. He had seen two or three cases of the kind treated by radium, but they showed burning of mucous membrane and increased ulceration. He recommended that these patients should be sent to a sanatorium and even have tuberculin treatment.

GAVIN LIVINGSTONE said he knew of a similar case in which the granuloma was in the right ethmoid region; it had been treated with a surface application of radium and had rapidly diminished in size. The mucosa of the nose did not become atrophic. Unfortunately a tuberculoma of the brain had developed, and further treatment was useless.

Persistent Epistaxis : Thrombocytopenia.—MAURICE SORSBY.

Female, aged 31, complains of persistent epistaxis. She has had bleeding from the nose since childhood. The attacks at first were of short duration and at long intervals, but eleven years ago she had severe attacks of epistaxis intermittently for several months. Cauterization led to marked improvement for a time. The attacks recurred, and the bleeding was particularly acute during pregnancy four years ago. The patient is still bleeding at frequent intervals, and sometimes loses large quantities of blood. She had to give up her housework because stooping, quick movements, and fatigue bring on an attack. The bleeding points in the septum have been touched with caustics, galvanocautery, and diathermy, giving immediate but transient improvement. She is now being treated with calcium (Sandoz) 10 c.c. intravenously twice daily, followed immediately by the application of ultra-violet rays (Dr. F. Nagelschmidt). Since the present treatment was begun the pathologist (Dr. Himmelweit) reports that the blood-platelets have increased from 39,000 to 230,000 and the red cells from 2,880,000 to 3,760,000. The coagulation time has been reduced from 5 min. 15 sec. to 4 min.; and the bleeding time from 6 min. 40 sec. to 4 min. 10 sec. The spleen is not enlarged, and radiologically all bones are normal. There was no undue bleeding on a tooth extraction, and the menses are normal.

ALEXIS TUMARKIN said that two years ago he had had a patient, aged 48, who had been bleeding from the nose since she was 14, and had had cautery and septal treatment on innumerable occasions. Her nose was full of black crusts; these she took out all at once and then the nose bled. She had a serious bleeding once a fortnight, and dripping of blood every day. In despair, he (the speaker) had tried radium, putting a 2 mgm. needle into one side of the nose, and leaving it in two days. The effect in checking the bleeding was dramatic. The

[1] See *Proceedings* 1927, xx, 1402 (Sect. Laryng., 50).

nose continued to bleed from the other side, and the patient had asked him to treat that side also in the same way. After waiting five months he had put in two needles for thirty-six hours; that was two years ago. She attended several times to report, and she never again had any troublesome hæmorrhage, though she was still troubled with crusts. He felt that if crusts could be prevented the case would be completely cured. He had tried a solution of bile in glycerine and alkali, and that had helped for a time, but afterwards the crusts had formed again.

Polypoid Hæmangioma of Pharynx.—MAURICE SORSBY.

A girl, aged 17, complained of increasing difficulty in speech; a year ago she had noticed that it was becoming thick and nasal. She was told that this was owing to nasal polypi. These were removed, but her speech grew progressively worse, becoming almost unintelligible.

A large polypoid mass was seen covering the larynx, and it was difficult to make out the site of origin. This became apparent when the head was thrown back during the operation. The mass was then seen to arise low down from the posterior pharyngeal wall. It was easily removed with a snare and the bleeding was stopped with the diathermy current.

Histological report (Dr. Himmelweit) "Polypoid hæmangioma.—*Pedicle*: Honeycomb-structure with numerous spaces full of blood. The lining cells are the same as those which compose the more compact parts of the tumour. They are endothelial cells with an oval nucleus and nucleolus. *Tumour*: The surface of the tumour is covered with squamous epithelium, which is œdematous and infiltrated with a certain number of round cells."

F. C. ORMEROD said that in 1926 [1] he had had a case in which the whole of one tonsil was replaced by a cavernous angioma, and it had to be dissected out. The procedure was a very long one, as he had to tie sixteen vessels. The patient was a woman. At that date he could find only twenty-two such cases reported in the literature.

Angioma of Fauces.—M. VLASTO.

D. V., a boy, aged 5. Two years ago his mother noticed that he had "a peculiar blue vein in front of the left tonsil." The first medical observation was made by Dr. Florence Edmunds, of Brighton, who reports as follows:—

"I first saw any signs of the angioma in September 1934. It showed as a slight blueing of the soft palate on the left side. In October it was about the same size, but when I saw it in December it was much larger."

A consultant advised the immediate insertion of radium needles.

The boy was brought to me for a second opinion on January 1, 1935. The diagnosis of cavernous angioma was confirmed. There was a complete absence of symptoms, and therefore I consulted Mr. Zachary Cope and Mr. Carter Braine as to the best way of dealing with the condition. We did not consider that any precipitate treatment was indicated, in view of the absence of symptoms and the duration of the angioma. Indeed, as the condition was so rare, no definite line of treatment could be decided upon. The insertion of radium needles would, we considered, involve a risk, and the prospect of severe hæmorrhage following electro-coagulation or diathermy had to be borne in mind.

We compromised by getting Mr. Shiells to make a painting of the throat condition so that we might have a standard of comparison in future observations.

[1] *Journ. Laryng. and Otol.*, 1926, xli, 797.

Discussion.—L. GRAHAM BROWN said the report he had received from radium workers was that they did not advocate the use of radium for cavernous angioma. His advice was to attack this growth by diathermy; it would enable the operator to control the hæmorrhage. Once a vessel was broken, the points could be quickly coagulated. He had recently dealt with an angioma of the orbit by this method.

ALEXANDER TWEEDIE said that he had a similar case which had been treated both with diathermy and radium, and the condition was partially controlled thereby.

DOUGLAS GUTHRIE asked whether it was not advisable to try first the effect of some coagulating substance, as employed in the treatment of varicose veins. The method was at least devoid of risk, and the technique was simple.

Section of Odontology

President—FRANK COLEMAN, M.C., L.R.C.P., M.R.C.S., L.D.S.E.

[*April* 15, 1935]

Principles Concerned in Tooth-Cavity Preparation

By Professor W. H. GILMOUR, LL.D., M.D.S., L.D.S.

FOR the purpose of this article a cavity is described as a break in the continuity of the surface of the crown of a tooth, creating an abnormal area or space, due to the loss of hard tissue, usually caused by caries, and occasionally by trauma, and provided that such loss of continuity does not involve the major portion of the external circumference of the tooth, and in any case leaves sufficient of the tooth crown into which retention of a filling may be established.

A filling is defined as the material used to fill a cavity in a tooth under the above conditions: (1) to prevent further loss of tooth structure, and (2) to restore its lost natural contour and anatomical relation to contiguous teeth, and the function of the tooth.

Filling materials at our disposal may be divided into two groups: (*a*) Plastic: (i) adhesive, and (ii) non-adhesive; (*b*) non-plastic.

Fillings may be retained in a cavity in several ways, e.g.: (1) By the inherent adhesiveness of the material used; (2) by keys or wedges formed in the tooth to retain the mass in position when solid; (3) by a combination of both.

Further, in considering the principles of cavity preparation, I intend to restrict my remarks to cavities occurring in teeth in which the pulp is still healthy and vital, as they are the more difficult to deal with. The retention of fillings in pulpless teeth is a comparatively simple matter since by the loss of the pulp the pulp chamber and the root-canal or canals are readily available to afford retention.

In describing the walls of the cavity I shall name them in relation to the surfaces of each tooth, as adopted by the Fédération Dentaire Internationale, namely: Facial (which will include labial and buccal), lingual (which will include palatal), distal, mesial, and occlusal, with the addition of a pulpal wall.

I shall also use the term "floor" meaning that portion of the cavity which will form the foundation of the filling and the angles described will be those formed by the junction of these various walls.

By the term "angle" is meant that part within the cavity formed by the junction of two or more walls and named after the walls concerned.

In the case of the anterior teeth, the occlusal surface is represented by a more or less thin line formed by the junction of the facial and lingual surfaces and spoken of as the incisive edge.

In the finished cavity it is essential to lay down:—

(1) That the retaining device for a filling must be made in sound dentine.

(2) That the remaining enamel must be supported by sound dentine.

(3) That the edges of the finished cavity must not come into contact with the surfaces of contiguous teeth or the edges of a contiguous filling, and must be free from the contact point.

(4) That the filling material must form the contact point of the contiguous tooth, or, in the case of two contiguous fillings, the contact point should be made by each other.

(5) That the edges of the cavity should be accessible for cleansing—either naturally or by other means—or, in the case of the cervical margin, protected by soft tissue.

Before proceeding to the classification of the cavities and the principles involved in each, it may be interesting and instructive to present the views and illustrations of earlier writers. From my limited reading I am not able to suggest how far back in the ages cavities have been artificially prepared, either as a means of repairing the ravages of caries or for decorative purposes. Dall describes South American Indians as decorating their anterior teeth by inlaying them with coloured stones some thousand years B.C.

In Harris's "Art of Dental Surgery," 1839, it is stated that plugging was performed in the first century. The term "plombage" used to this day by the French to denote a filling dates from the use of lead.

Since the early materials used for fillings were non-adhesive and were prepared in the form of foil from lead, tin, and later, gold, they depended for their retention on being packed or wedged tightly into a cavity from which caries had been removed. The retaining walls of the cavity had, therefore, to be strong enough to withstand the requisite strain of filling, and the inside of the cavity had to be larger than the external orifice in order to retain the mass.

Mrs. Lindsay, to whom I appealed for information on this point, says that "Early authors on cavity preparation simply say 'Cut out the decay and fill.'"

Fauchard, 1728, gives no description as to how the cavity is prepared. Bourdet, 1757, describes the instruments which should be used in order that the filling may be adapted to all corners of the cavity, thus suggesting a wedge formation. Berdmore, 1770, and Rae, 1782, speak of a cavity as a hole. Fox, 1814, makes no mention of the shape of the cavity, but states that when a filling is inserted in the sides or between the teeth pressure of food is liable to displace it. Thomas Bell, London, 1835, states that the cavity to be filled should be narrow in proportion to its depth and if practicable should be made larger within than at its external orifice. Chapin A. Harris, 1839, describes the cavity as a very little larger internally than externally—the principle again incorporated in the edition of 1845. In the 1850 edition he states that the cavity must be so shaped that when properly filled there is no liability of the filling coming out. Robert Arthur, 1857, describes the cavity as a little larger than the orifice. He was the first to introduce starting-points. John Tomes, 1859, regards the cylindrical hole as the most suitable for the reception of a plug, and suggests that overhanging edges must be cut away sufficiently, if not to produce rectilinear walls, to reduce the angles to moderately curved surfaces. "The strength of the walls of the cavity is a very important subject." He suggests starting-points if cohesive gold is to be used.

S. J. A. Salter, 1874, suggests that tooth-stopping is now so mechanical that it does not come within the scope of dental surgery.

Coleman, 1881, speaks of filing and polishing to remove cavities, as do earlier writers, and seems to be the first to describe wedges or the keying process and the use of retaining pits or grooves. He made use of hand drills. "The American System of Dentistry" (edited by Wilbur Leitch, vol. ii, 1887), suggests that where cohesive gold only is used, a pit should be made, care being taken as to the proximity of the pulp and suggests that the cavity be larger inside than out, the undercutting of the walls and use of pits and grooves. He also describes the manner of wedging in an

interstitial cavity (incisor). Tomes' "Dental Surgery," 3rd edition, 1887, describes the single wedge form for occlusal cavities and the use of pits in interstitial incisor cavities. Smale and Colyer, "Diseases and Injuries of the Teeth," 1893, describe and illustrate the wedge formation in incisor teeth, the double wedge for mesio-occlusal cavities and retention by the use of pits and grooves. C. A. Harris, "Dental Art," 1839, makes the first reference to the introduction of amalgam under the name of "royal mineral succedanium" the same as advertised in 1834, and by the introduction of cohesive gold in 1885, material was available to make possible the restoration of all forms of lost contour and demanded a variety of differently shaped cavities. The technique of the preparation of such cavities was rendered much less difficult by the introduction of the dental engine by Morrison, thus allowing of the use of burs instead of hand drills, further accelerated by improvement in burs and handpieces to retain the same.

My training was based on the principle that the cavity should be larger inside than out (1891-92) and suggestive of wedges, but mainly depending, in the case of gold, on retaining pits and grooves. The publication of a book, "Methods of Filling Teeth," by Ottolengui, stimulated me and first interested me in retention methods. My failures were particularly helpful and won my appreciation of the mortise method. On examining a filling which I removed from an extracted tooth into which I had inserted it many years previously, I was struck by its wedge-shaped formation and convinced that properly designed wedges were the most efficient, and pits and grooves rarely necessary.

Another work which distinctly impressed me was that of Kirk—"Operative Dentistry," 1912—the illustrations in which, under the heading of "Technique and cavity preparation," are of such beauty as to be understood even without reading the text. He described and illustrated the common and complex mortises used by mechanics, and their adaptation in cavity preparation, together with the triangular form and wedging in interstitial incisor cavities. I was gratified to find that without any previous knowledge of his work, I had developed my cavities on similar lines, as a result of experience.

Black (Operative Dentistry, 1908) classifies cavities mainly in reference to the positions in which they occur and the manner in which they extend, as follows:—

Class 1.—Cavities beginning in pits and fissures in any parts of teeth in which these occur.

Class 2.—Cavities beginning in the proximal surfaces of bicuspids and molars.

Class 3.—Cavities beginning in the proximal surfaces of the incisors and cuspids which do not require the removal and restoration of the incisal angle.

Class 4.—Cavities beginning in the proximal surfaces of the incisors which require the removal and restoration of the incisal angle.

Class 5.—Cavities beginning in the gingival third—not pit or fissure cavities—of the labial, buccal or lingual surfaces of teeth.

Yet notwithstanding the apparent thoroughness of Black's classification I found on my visit to America that many of the schools were not satisfied with it and were adding to it by further division.

I prefer to adopt a more simple classification, incorporating the principles of retention rather than that based on the position in which the cavities occur, and for years have practised and taught the principles of cavity-preparation based on the following classification when the filling is composed of one single material:—

Class 1.—Composed of a single wedge, notwithstanding their ramifications. They are surrounded by dental tissue and confined to one plane of the tooth, the pulpal wall forming the floor, e.g. occlusal cavities, fissures, buccal and lingual fissures or pits, the mesial or distal surface of a tooth if a tooth is missing.

Class 2.—Composed of two wedges involving two planes with the floor of the cavity at the cervical margin, mainly formed in premolars, molars and canines. If in incisor teeth the floor is formed by the facial wall with a key in the lingual wall.

Class 3.—Composed of more than two wedges and confined to interstitial cavities in incisor teeth and canines.

By the above three classes and their combination practically all types of restoration can be undertaken. This classification has the merit, to my mind, of simplifying cavity preparation, as it is based on the internal formation, irrespective of position.

Where the inlay method of restoration is adopted it is necessary to have a different classification and a different technique of preparation and will be dealt with separately.

Before I explain my method of preparation I would like to make a brief note on the instruments used.

FIG. 1.

First and foremost, I prefer straight instruments, but if curved ones are used the working point should be near the centre of the long axis of the handle. It is better to use a few instruments and get to know them thoroughly, than to make an accumulation of all forms.

Chisels should be sharp and maintained in their sharpness, and discarded if sharpening does not make them efficient.

Chisel excavators—rarely used—must also be kept sharp.

Spoon excavators—straight spoon in particular, and two types of curved—must be kept constantly sharp by honing.

Stones are commonly used, particularly in these days when there has been such improvement in their manufacture.

Use of engine: I feel that the method of gripping the handpiece is of paramount importance. I grip them in two ways: (1) The pen-grip with the middle-finger rest (fig. 1); (2) the first-finger-and-thumb grip, with the thumb rest (fig. 2).

For the right angle and obtuse angle I use, mainly, the pen-grip with the middle-finger rest, and less commonly, the finger-and-thumb grip with the thumb rest.

Burs.—Three types only are needed: (1) Fissure: Their use is obvious, namely, to open up cavities and to form the sides of the keys or wedges, particularly in Class 2 cavities; (2) Inverted cone: Its furthest end used to flatten the floors and its sides to slightly undermine the walls in Class 1 cavities only; (3) Rose-head: can be used in all directions, very rarely as a drill—occasionally for cutting from inside outwards and removing overhanging walls or edges. The sides provide the fullest and most efficient portion, that is, at its greatest diameter at right angles to its shaft, and used almost in the manner of scribing, keeping the most perfect control as to its cutting and using from the lightest to whatever force is required by lateral pressure.

Separation.—Where interstitial cavities occur the teeth should be separated artificially, provided such separation has not already occurred, owing to the

FIG. 2.

irritation and thickening of the interdental septum. The amount of separation needed is only such as to allow of the thickness of a Moore's disc or strip between the finished contact-point of the filling and that of the contiguous tooth or filling, thus allowing the tooth to come into normal position with the minimum of movement. Over-separation tends to damage the tissues and prevent their return to normal position. Occasionally if the tooth is crowded, separation is not necessary.

Survey.—Before opening up a cavity or breaking-down the walls, one should carefully survey the plane or planes of the tooth involved and determine the amount of damage which has taken place and form a fairly definite plan as to how it is intended that the cavity should be developed. The shape, having been determined, the obviously unsupported and damaged enamel should be removed

by bur or cleavage by chisel, sufficient to allow the inside extent of the cavity to be estimated. The walls should not be cut away too generously, even if at first they do not appear ideally strong. With either bur, stone, or chisel, the enamel should be removed so as to leave the wall in the line of the prisms. Easy access having been gained by the use either of the spoon-excavator or of burs, the obviously damaged internal tissue is easily seen and removed.

After removal of the defective tissue the walls may need further trimming, as the decay may have spread more extensively under one wall than another. Even then one should not be over-generous in its destruction at this stage. Again, enamel should be cleaved in such a way as to leave the edges of the cavity in long curves rather than in short ones, even if a fair amount of perfectly sound tissue has to be sacrificed in order to gain such shaping, retaining in all cases, within reason, as much of the facial surface as will serve to hide the filling, should it not assimilate in colour to that of the tooth itself. The end-result of this will give a more or less saucer-shaped cavity.

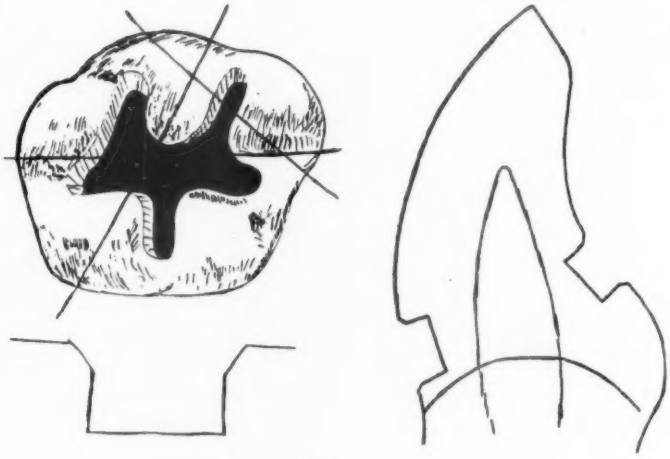

FIG. 3.

Class 1 (fig. 3).—If this occurs in fissures or extends into fissures, the fissure bur is used and carried along to the end of the infected fissure or fissures in each direction. The enamel is then broken-down with the chisel, and, if necessary, the spaces in the fissures are enlarged to allow for the filling. This is done till the walls are practically straight and the rest of the caries is excavated or drilled out. I then choose as large an inverted cone as I feel will pass along each of the fissures, and, with the same cut, shape the cavity, removing the secondary enamel decay, and/or carious dentine. The size of the inverted cone will vary with the size of the fissure. For the central portion I use as large an inverted cone as the cavity will allow and run it round the walls, slightly undercutting them, at the same time running it into the cavity so as to flatten the floor. The occlusal walls are then bevelled if gold is to be used. The outline of the cavity will vary in accordance with the direction of the fissure and the size of the main central cavity.

For a cervical cavity on the facial aspect of incisors I choose a rose-head bur which I estimate will cut out the full width of the decayed area and leave a sound enamel edge. This will produce a definite saucer-shaped cavity, either perfectly round or crescent-shaped, according to its ramification. I then take an inverted cone, slightly less in size, driving it into the tooth to flatten the floor and drawing it round the walls to slightly undercut them, thus completing the operation in two movements.

Class 2 (fig. 4).—When dealing with an interstitial cavity where the break into the occlusal surface is not definite—that is, when the edges almost touch the contiguous tooth—I take a No. ½ (American gauge)[1] rose-head and break through its extreme edge and then pass a No. ½ or a No. 1 fissure bur into it towards the centre of the tooth, holding the fissure bur obliquely, that is, with its tip always furthest away from the pulp. I then retain the same fissure bur, cutting towards the lingual aspect as far as I feel the damage to the tooth extends, then coming back to

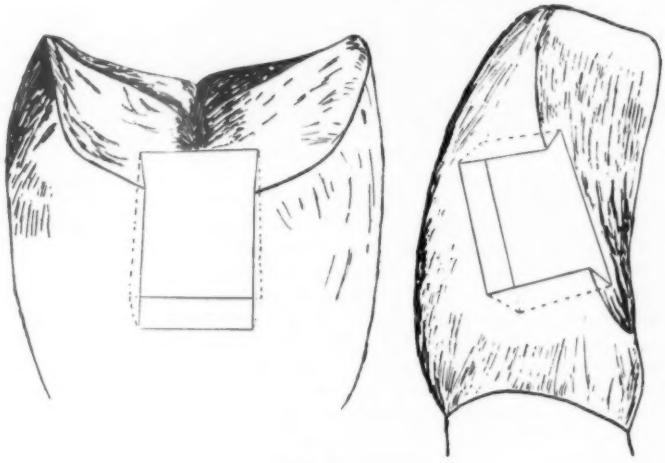

FIG. 4.

the centre and making a similar cut towards the facial side, thus giving two cuts in the form of a T, one antero-posteriorly and the other linguo-facially. I then crash in the overhanging enamel, but in such a way as to leave the broadest portion towards the pulp, and then interstitially chisel down the lingual and facial walls until they are extended into a safe area. This thoroughly exposes the cavity. The damaged tissue is removed by chisel or spoon-excavator, or even by bur, and the cervical margin or floor is chiselled or stoned down until all damaged enamel is removed. A fissure-bur with a square end is then introduced and run down from the occlusal surface; the bur is held in such a way that its deeper portion will be definitely nearer the lingual wall at its base, and it is worked straight across and in contact with the floor until the facial wall is reached. In this case the end of the bur should be nearer the facial wall than that portion which is cutting the occlusal surface. The cavity is then examined and shaped in this way until the cervical floor is flat and dips slightly inwards, the pulpal wall is flat and the lingual and facial

1 Sizes of burs : ½ = 0·6 mm. ; 1 = 0·8 mm. ; 2 = 1 mm.

walls also slope slightly inwards. The angles are finally accentuated by a No. ½ fissure or rose-head bur. The lingual and facial walls are then trimmed to follow the contour and cut parallel to the enamel prisms. The cervical margin is bevelled, as are also the occlusal edges if for gold, and the joint of filling and tooth is pleasingly curved.

Occasionally there may be a Class 2 cavity in the incisor region. In this case the floor of the cavity is formed by the facial wall and the keying is shown on the lingual wall. Such cavities, of course, have to be prepared and filled by reflection. They have the advantage that frequently where the lingual wall has been very badly damaged, there is less loss of sound tissue in forming the key and the facial wall will hide the filling material. If, for example, one finds, as one frequently does in this class of cavity, the occlusal fissures are involved, then one extends and shapes the fissures just as one does the simple Class 1 cavity. Such fillings then become a combination of the two types (2 and 1).

Class 3.—In this class of cavity the extent of the damage should be carefully noted and a definite plan devised before any of the tissues are broken down. When the ultimate shape has been visualized the very obviously unsupported enamel is removed by chisel, the direction of the edge of the chisel being altered in accordance with the surface being cut so as to leave the enamel prisms in their entire length and not at first cut away too generously. The internal damage is then more fully realized and the obviously damaged tissue removed by a spoon excavator or burs. Following this it may be necessary to trim the walls further if the enamel has become undermined by caries. The curve given to the wall, as these cavities occur mostly in incisors and are more readily visible, should be long and gradual, even if one extends the cavity by sacrificing some sound tissue. In this way one creates an optical illusion by lengthening the curve, thus making the filling look narrower or less conspicuous, though, in fact, the cavity is larger. The exposed walls should be shown in one curve and not waved, ideally a small segment of a large circle rather than a large segment of a small circle. This particularly applies when the filling material used does not assimilate the colour of the tooth. The cavity at this stage will be saucer-shaped (fig. 5*a*). I then, with either a No. 2 or No. 1 rose-head, according to the size of the cavity, and using it as a graver, outline the internal shaping, cutting into the dentine in such a position as to leave it supporting the enamel in all directions, starting from the cervico-facial angle, taking the bur rapidly inside the cervical margin to the cervico-lingual angle, coming back, engraving from the cervico-facial towards the incisive edge, this depending upon the length of the cavity; then I proceed from the cervico-lingual angle, drawing the bur in a straight line to meet the other line, thus outlining a triangle. Having graved these lines one can easily then accentuate them with the next size rose-head bur, using it in the same manner, point to point, making the angles more definite, so that at the two cervical angles, labial and facial, one cannot pass round the angle formed, being obliged to change the direction of the bur abruptly, and when the labial and facial angles meet towards the incisive edge, dipping the bur so as to slightly undermine the cavity at that point. If in this movement the damaged tissue is not all removed it should be further excavated by bur or excavator, and the walls, if weakened thereby, should again be chiselled till of requisite strength, and the cavity should be re-shaped. At this stage the walls should be practically parallel but with the angles fairly rounded (fig. 5*b*). Then with a No. ½ rose-head bur the angles should be more definitely accentuated so that there is a more abrupt junction in the two cervical angles (labial and facial), and at the incisive or opposing point, the bur again being very definitely dipped (fig. 5*c*, also fig. 6). A cavity prepared in this way will show five different keys: (1) At the cervical margin; (2) from the cervico-facial angle to the incisive or opposing point; (3) from the cervico-lingual angle to the incisive or opposing point; (4) from the pulpal wall outwards (cross-

a *b* *c*

FIG. 5.

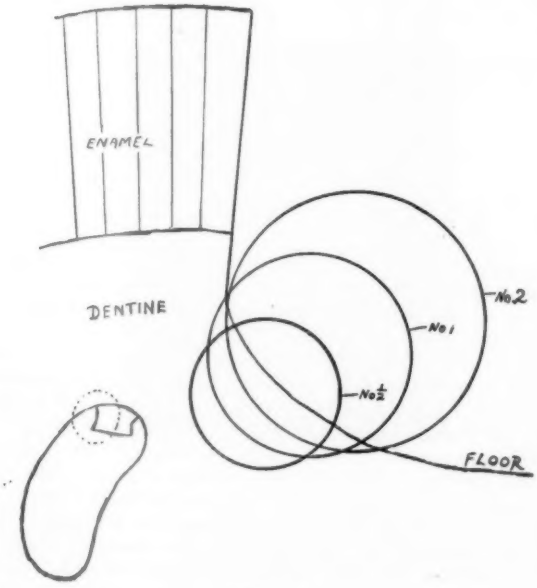

FIG. 6.

section) for the whole length except at the opposing point; (5) from the incisive or opposing point to the cervical floor in longitudinal section through the tooth (fig. 7).

If, for example, one has to sacrifice the centre of either wall, facially or lingually, and it is found that in attempting to form an angle down the whole length of either one runs the risk of exposing the pulp, the centre portion, in such a case is left flattened, the cervical and opposing keys still remain, and the wedging effect will not be complete until the whole filling is inserted. When the incisive edge of an incisor tooth is involved, and it is impossible to make the ordinary opposing point, one forms a Class I cavity along the incisive edge between the plates of enamel, thus combining Classes 3 and 1. The walls are finally finished either with a chisel or with a stone. I prefer the latter as they are now so well made, leave a smoother surface than that made with a chisel, and are economical in use. The walls are so trimmed that their planes, when exposed, follow the whole length of the enamel prisms which, of course, will vary with the contour which has been cut into. The

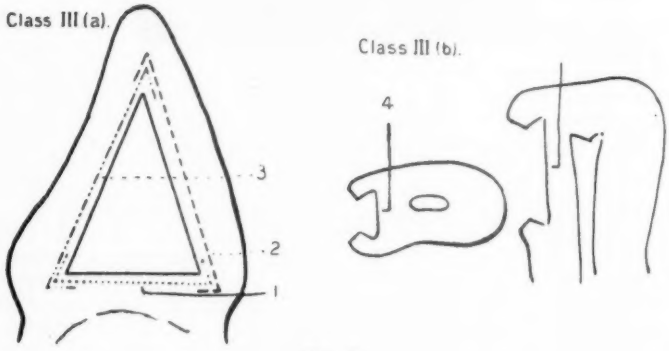

FIG. 7.

line of the prisms may be roughly described as radiating from the pulp as a common centre, or at as near a right angle as possible to the surface of the tooth which is being cut (fig. 8). In order to give some indication of these lines, I have prepared a slide of a plaster tooth which is used as a technique model in Toronto, holes being drilled into it in accordance with lines of prisms from the surface and pins placed in them to show how they either converge or diverge with the particular contour (fig. 9). The object to be attained, in the main, is equal strength or line of junction to the tooth and the filling wherever it may be. Bevelling, however, if gold is to be used, is definitely resorted to if the cavity approaches the incisive or occlusal surfaces, and in all cavities involving the cervical margin. The latter is done especially so as to get a fairly broad foundation on which to support the mass and contour of the filling, and, when almost approaching the termination of the enamel in large cavities, to remove the thin edges of the enamel which may remain interstitially. By bevelling, I mean so cutting the wall that the filling will overlay the enamel on the outer edge, or at the exposed outer end of the prisms. There is no necessity to make starting-holes or pits in the cervical floor or to sink

opposing pits towards the incisive edge. Drilling them is painful or dangerous; if they are large enough for starting gold or to afford a good retention there is a risk of their coming too near the edge or the pulp, and if they are too small there is the

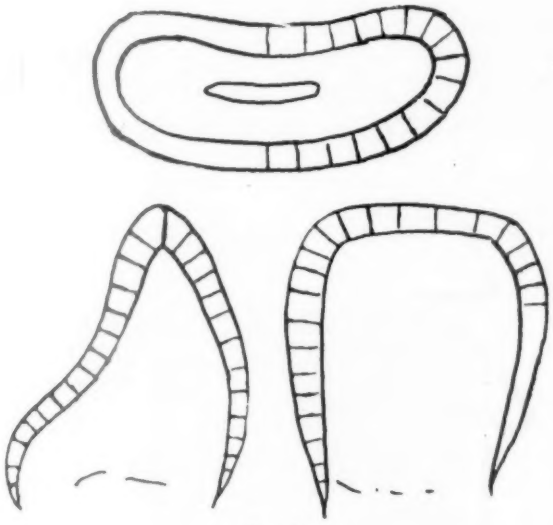

FIG. 8.

FIG. 9.

risk that the filling material may not enter them. Further, I find no necessity to make grooves, for similar reasons, and because of the added risk of undermining the walls of the cavity, and thereby weakening them and leaving potential lines of

cleavage (fig. 10). The cervical floor should dip slightly on the inner, or pulpal, wall and the facial and lingual walls have the merest extension beyond the parallel, that is, they should be slightly wider inside than out, and the opposing point should only dip into an angle and not into a deep pit. The pulpal wall, so far as possible, should be kept flat, unless, of course, in a fairly large cavity there is a risk of exposing the pulp—then it may be left rounded.

I make little difference in the preparation of a cavity for either a plugged or plastic filling, but in the latter case more licence can be taken. One can risk preparing slightly thinner walls and one can place the material, being plastic, into less accessible portions of the cavity. Cement, being adhesive, adheres to and strengthens the walls.

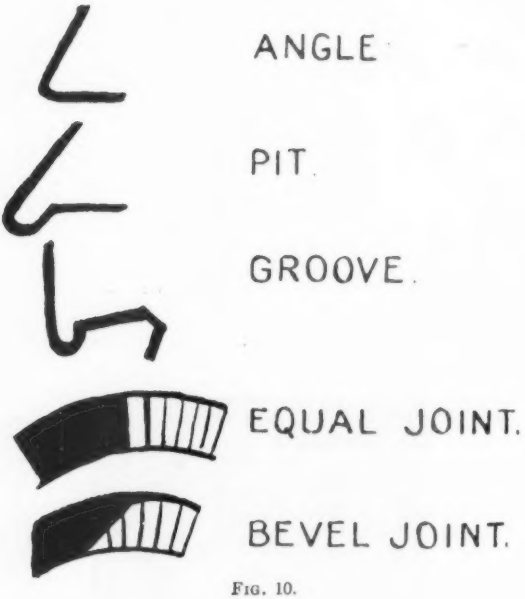

FIG. 10.

Since the use of burs and stones in high-speed electric motors tends to develop heat, I prepare most cavities by the so-called " wet " method, unless there is grave risk of an exposure, and even then I complete that portion of the cavity lying nearest to the gum before isolating the tooth with rubber dam. I also prefer the wet method because during the preparation the débris can be washed out more readily, leaving a perfectly clean cavity.

Desensitizing the tooth or area is now almost routine and has rendered cavity preparation an easy task, but one needs a perfect knowledge of tooth anatomy, since pain, which is a useful symptom, is eliminated, and so the pulp may be unduly endangered and an exposure not discovered until the recovery of sensation.

Inlays.—An inlay is defined as a mass of cast metal, or ground or fused porcelain, prepared in a complete form for insertion into a cavity in a tooth in order to restore its function and contour, and sealed into position by means of a lute, together with, or

without, a retention key or wedge. This method allows of a much larger restoration being undertaken than is usually possible with fillings.

Cavities for inlays.—I classify these as follows:

(1) Box form: in which the walls very slightly diverge from inside outwards—flat floor (M.O.D. cavities are essentially double-box cavities connected occlusally).

(2) Single key or wedge form: to prevent interstitial thrust, the cervical floor is made flat to provide a square seating; the walls are slightly divergent at the orifice to allow of the withdrawal of the matrix in the long axis of the tooth.

Form 1 is prepared in much the same manner as either Class 1 or Class 2 according to position (*vide supra*) except that the orifice is slightly larger than the interior.

Form 2 is applicable to: (*a*) mesio- or disto-occlusal cavities in either premolars or molars. The key or wedge is formed in the occlusal surface and extends to a flat cervical floor. It is prepared in a manner similar to Class 2, except that the orifice

FIG. 11.

in the occlusal surface should be slightly larger than the deeper portion of the cervical floor of the cavity; (*b*) incisors and canines. The retaining key for (*b*) is made in the lingual wall of the cavity by cutting through it with a No. 2 square-ended fissure-bur run parallel with the facial wall and extending down to the cervical floor, then carried backwards across to that portion of the lingual wall towards the cingulum. This is followed by a No. 1 fissure-bur used in a similar manner to accentuate the angles, followed further by a No. ½ fissure or No. ½ rose-head to define the angle in the long axis of the tooth, leaving the orifice slightly larger than the deeper portion. The facial and lingual walls are cut away so as to allow the impression or matrix to be withdrawn in the long axis of the tooth and to separate immediately from the walls (fig. 11). The incisive edge and lingual walls are bevelled for metal inlays and left square in the case of porcelain. Inlays in Form 2 cavities are sealed in by a lute which retains them in position in the long axis of the tooth, the lingual key preventing their displacement interstitially.

In all cases should the floor of a cavity become uneven in following isolated areas or more deeply penetrating caries, it is permissible and advantageous to flatten this with cement in order to prevent undue loss of sound tissue and, if approaching the pulp to insulate it, provided that, in so cutting the dentine support, the sound enamel is not removed. In the latter event the tissue must be cut back until the enamel is supported by sound dentine.

One's appreciation of retention is much increased by noting the inner portion of a filling or cast of a cavity.

A useful accomplishment to encourage is ambidexterity so that one can still stand at the right side of the chair, changing the handpiece from the right to the left hand, thus making the preparation of distal cavities more simple.